



849 NW STATE ROAD 45
NEWBERRY, FL 32669 USA
PH: 888.472.2424 OR 352.472.5500
EMAIL: INFO@TIMCOENGR.COM
[HTTP://WWW.TIMCOENGR.COM](http://WWW.TIMCOENGR.COM)

FCC PART 87 TEST REPORT

APPLICANT	ROCKWELL COLLINS, INC.
	1300 WILSON BLVD. SUITE 200 ARLINGTON VA 22209 USA
FCC ID	AJK8223334
MODEL NUMBER	HFS-2100
PRODUCT DESCRIPTION	HF TRANSCEIVER
DATE SAMPLE RECEIVED	12/6/2017
DATE TESTED	12/8/2017
TESTED BY	Tim Royer
APPROVED BY	Franklin Rose
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Version Number	Description	Issue Date
2092UT17TestReport	Rev1	Initial Issue	12/18/2017
	Rev2	Updated technical info	03/18/2018
	Rev3	Updated technical info	4/3/2018

**THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL
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GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

Summary

The device under test does:

- ☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.
- ☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669

A blue ink signature is written over a circular purple stamp. The stamp contains the text "TIMCO ENGINEERING, INC." around the perimeter.

Tested by:

Name and Title: Tim Royer, Project Manager/Testing Engineer

Date: 12/18/2018

A blue ink signature is written over a circular red stamp. The stamp contains the text "TIMCO ENGINEERING, INC." around the perimeter.

Reviewed and approved by:

Name and Title: Franklin Rose, Project Manager/Testing Technician

Date: 01/08/2018

GENERAL INFORMATION

EUT Specification

EUT Description	HFS-2100
FCC ID	AJK8223334
Model Number	HFS-2100
Operating Frequency	2-30 MHz
Test Frequencies	3.0, 5.1, 8.9, 13.6 & 21.5 MHz
Emission Designator	2K80J3E/H3E, 2K80J2D
Type of Emission	Analog and Digital
Modulation	AM, M-ARY PSK
EUT Power Source	☐ 110–120Vac/50– 60Hz
	☒ DC Power
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☒ Pre-Production
	☐ Production
Type of Equipment	☐ Fixed
	☒ Mobile
	☐ Portable
Test Conditions	The temperature was 26°C with a relative humidity of 50%. Atmospheric Pressure: 30.01"
Revision History to the EUT	None
Test Exercise	The EUT was placed in continuous mode using either an analog or digital transmitting scheme
Applicable Standards	ANSI/TIA 603-E:2016, FCC CFR 47 Part 87
Test Facility	Timco Engineering Inc. 849 NW State Road 45 Newberry, FL 32669 USA. Designation #: US1070

RESULTS SUMMARY

FCC Rule Part	Requirement	Result
2.1046, 87.131	RF Power Output	Pass
2.1047, 87.141	Modulation Characteristics	Pass
2.1049, 87.135, 87.139	Occupied Bandwidth	Pass
2.1051, 87.139	Spurious Emissions at Antenna Terminals	Pass
2.1053, 87.139	Field Strength of Spurious Emissions	Pass
2.1055, 87.133	Frequency Stability	Pass

RF POWER OUTPUT

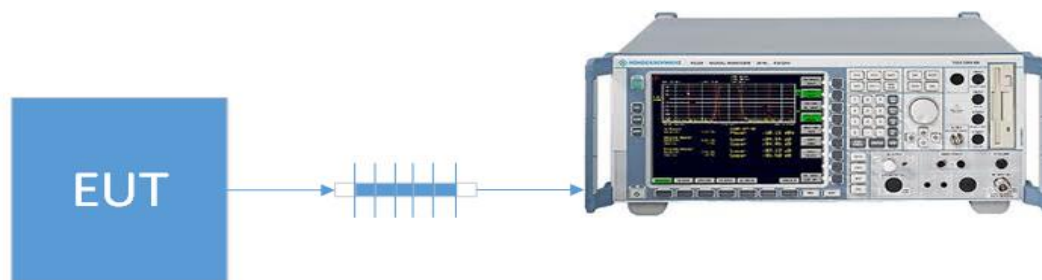
Rule Part No.: Part 2.1046, Part 87.131

Requirements: Manufacturers Specifications

Procedure: RF power is measured by connecting a 50-ohm, resistive wattmeter to the RF output connector. With a nominal battery voltage and the transmitter properly adjusted the RF output measures:

For the Device has a fixed antenna, RF power is measured as Peak envelope power. With a nominal battery voltage and the transmitter properly adjusted the RF output measures:

Setup Diagram:



Test Data: Peak Measurement Table

Tuned Freq (MHz)	Pconducted (dBm)	Pconducted (W)
3	55.35	342.8
5.1	55.49	354.0
8.9	55.51	355.6
13.36	55.34	342.0
21.5	54.89	308.3

Part 2.1033(c) (8) AC Voltages & Current into Final Amplifier:

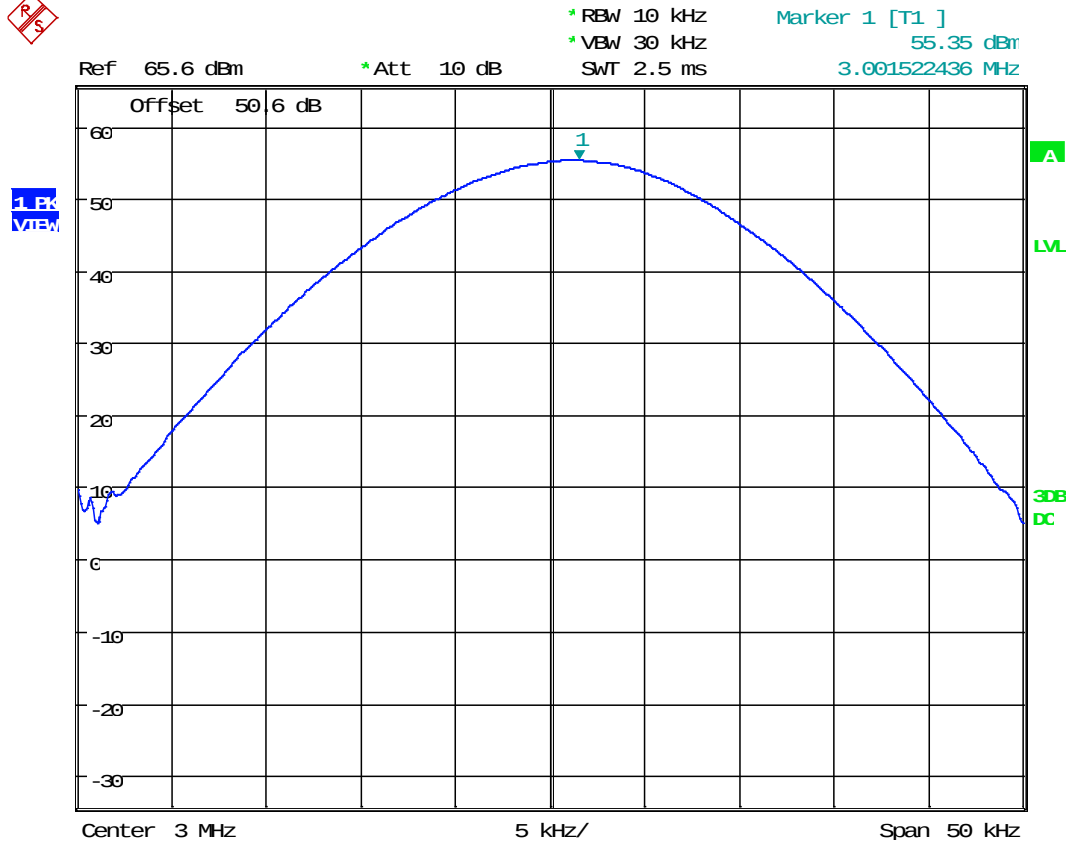
POWER INPUT:

FINAL AMPLIFIER ONLY

The System was rated at 750 Watts from customer provided documentation

RF OUTPUT POWER

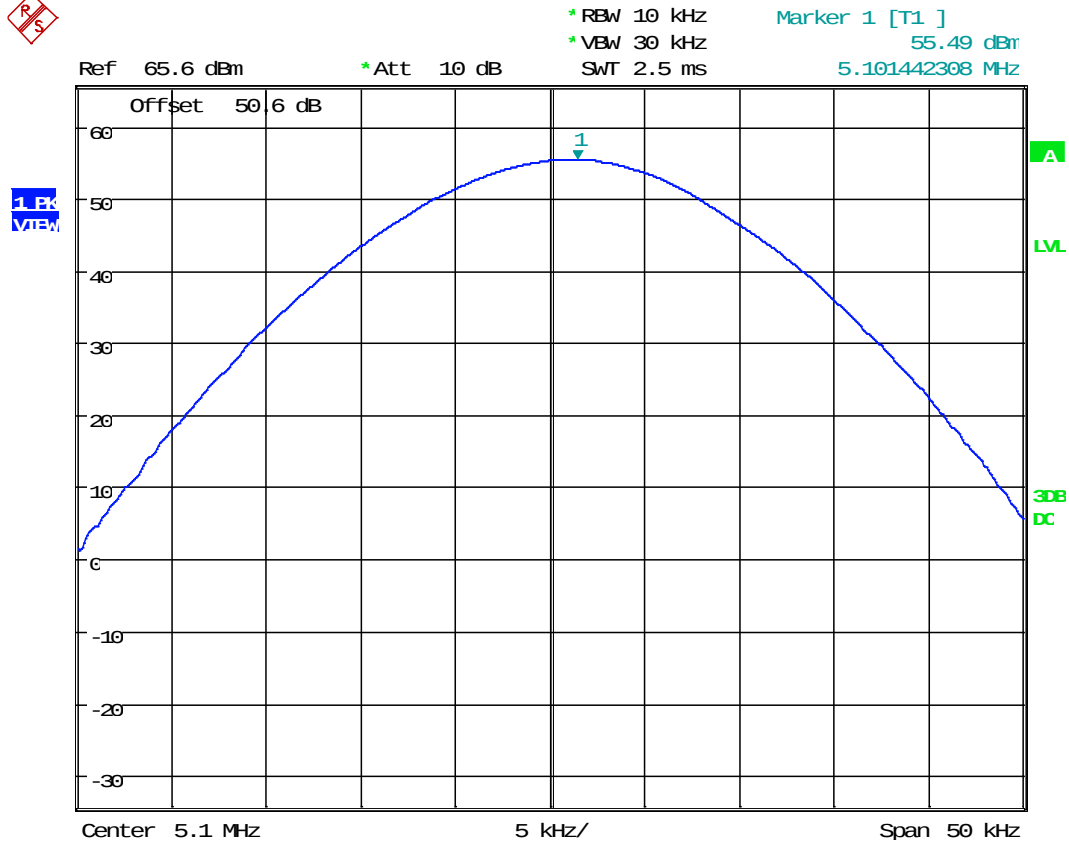
Test Data: 3 MHz



Date: 12.DEC.2017 15:21:19

RF OUTPUT POWER

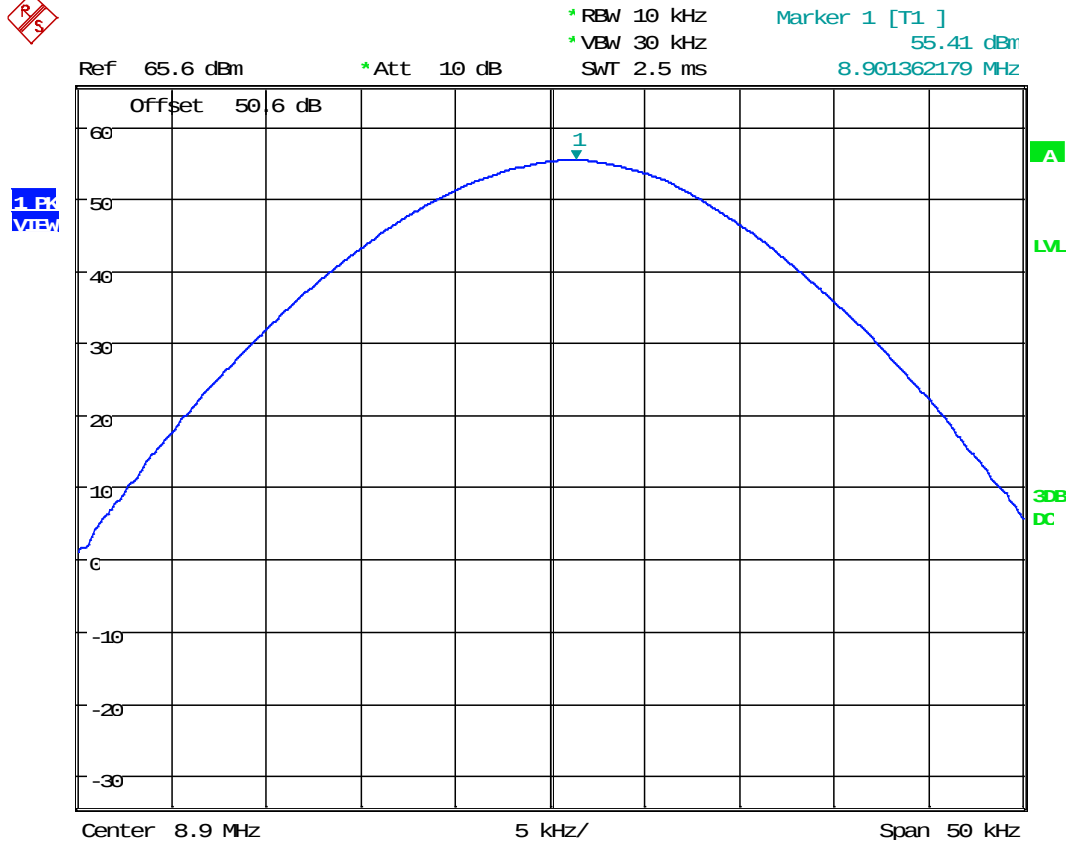
Test Data: 5.1 MHz



Date: 12.DEC.2017 15:21:49

RF OUTPUT POWER

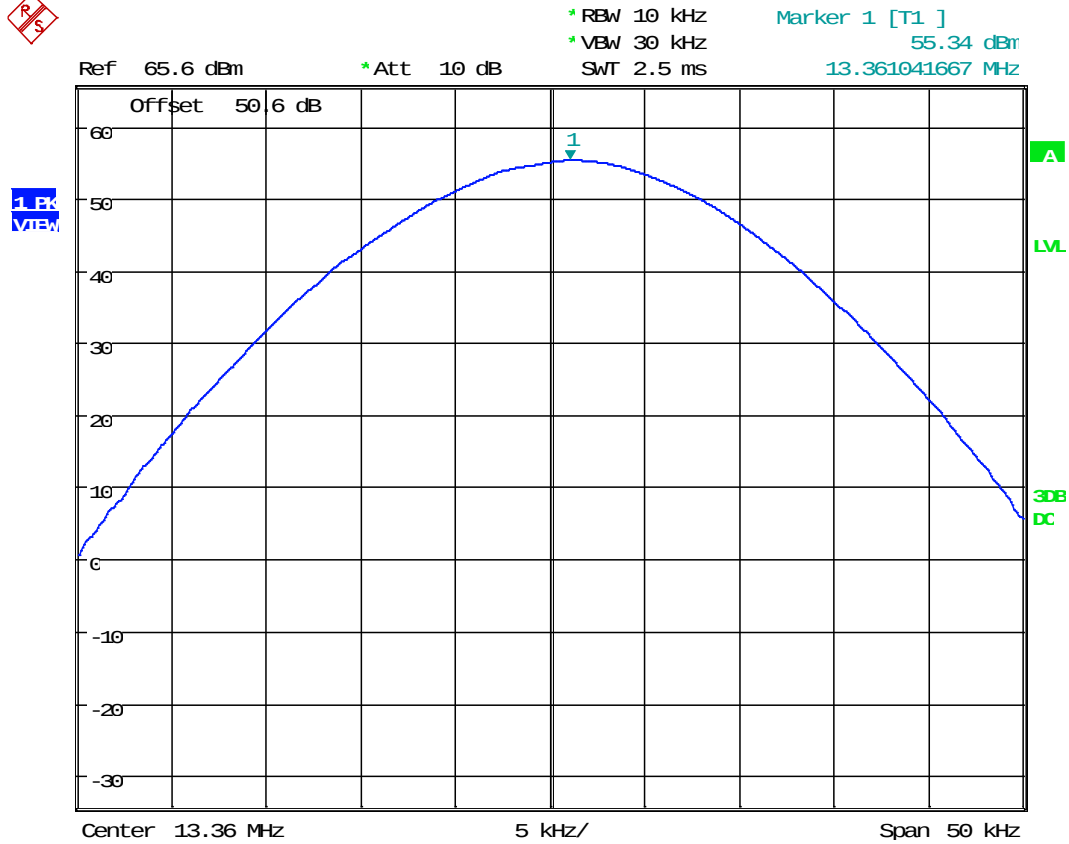
Test Data: 8.9 MHz



Date: 12.DEC.2017 15:22:22

RF OUTPUT POWER

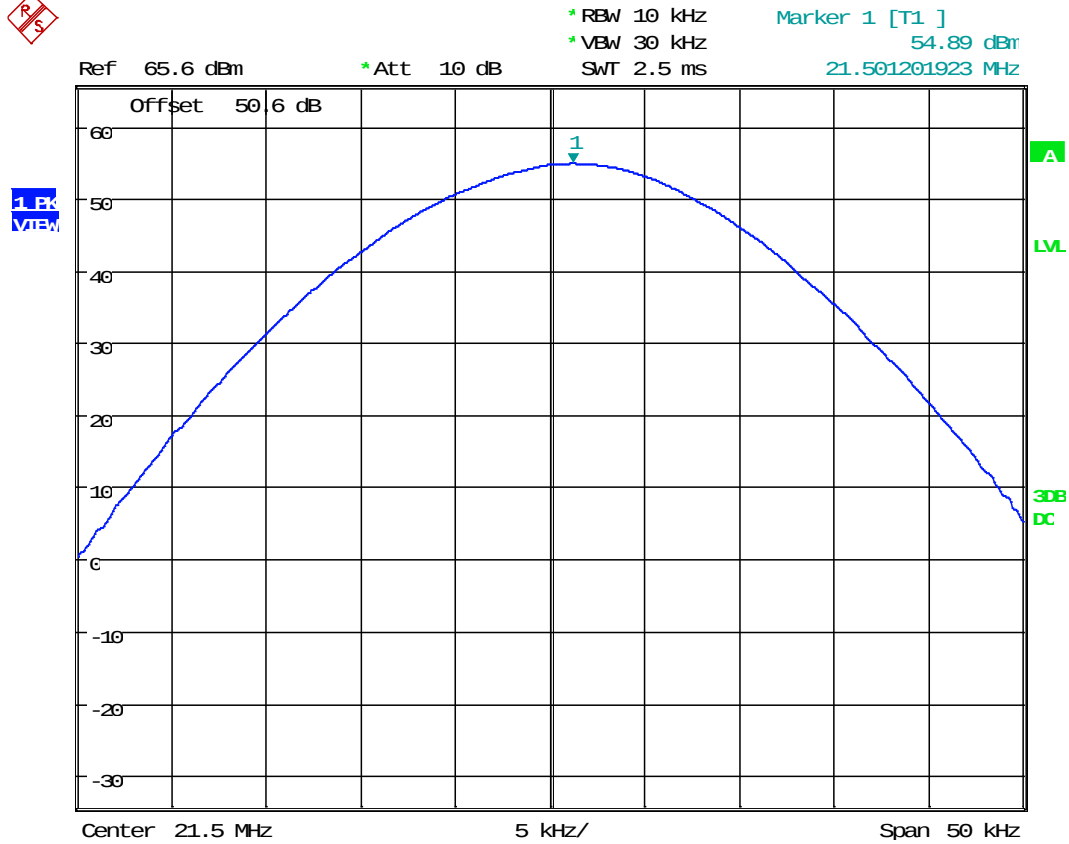
Test Data: 13.36 MHz



Date: 12.DEC.2017 15:22:59

RF OUTPUT POWER

Test Data: 21.5 MHz



Date: 12.DEC.2017 15:23:38

MODULATION CHARACTERISTICS

Rule Part No.: Part 2.1047(a)(b), Part 87.137 (a)

Types of Emission:

2K80J3E/H3E

2K80J2D

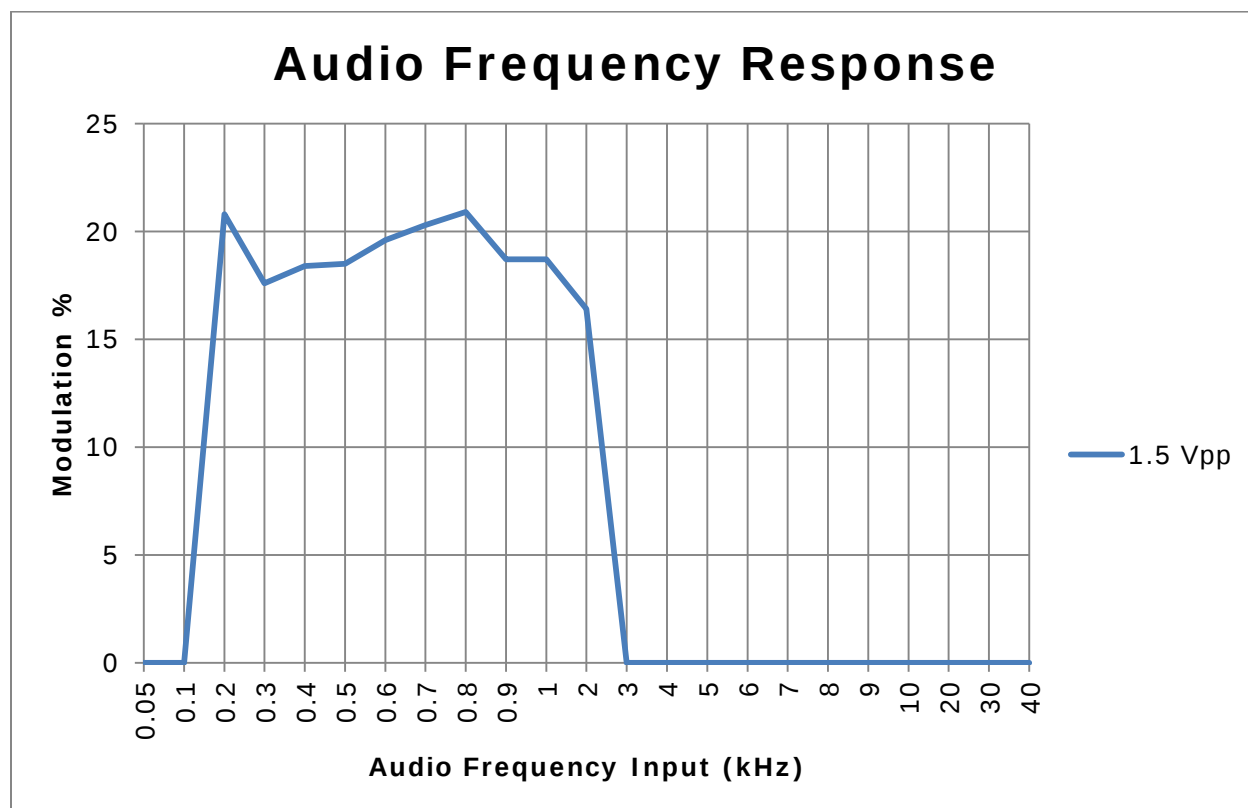
The authorized bandwidth is 3 kHz.

MODULATION CHARACTERISTICS

Rule Part No.: Part 2.1047(a)(b)

Test Data: Audio frequency response

The audio frequency response was measured in accordance with TIA/EIA Specification 603 with the exception that for an AM modulated transmitter the input was varied for a constant modulation of 20%. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 – 5000Hz shall be submitted. The audio frequency response curve is shown below.



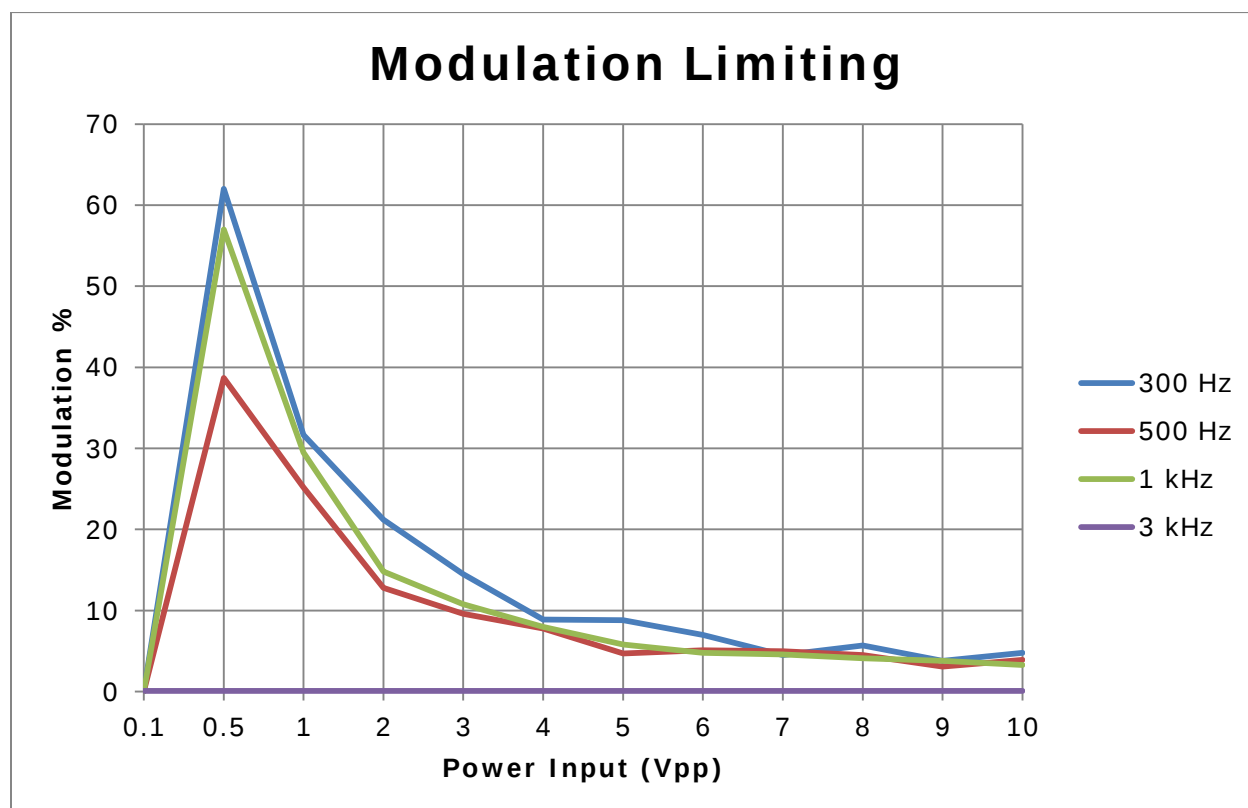
VOICE MODULATED COMMUNICATION EQUIPMENT

AUDIO INPUT VERSUS MODULATION

Rule Part No.: Part 2.1047(b) & 87.141

Method of Measurement: Modulation cannot exceed 100%, The audio input level needed for a particular percentage of modulation was measured in accordance with TIA/EIA Specification 603. The audio input curves versus modulation are shown below. Curves are provided for audio input frequencies of 300, 1000, and 2500 Hz.

Test data: Modulation Limiting



OCCUPIED BANDWIDTH

Rule Part No.: 2.1049, 87.135, 87.135, 87.139

Test Requirements: see below

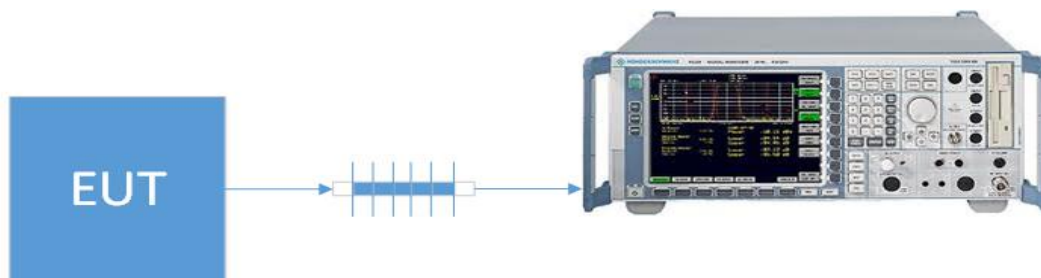
(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 30 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 38 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 3.0 kHz for aircraft transmitters the attenuation must be at least 43 dB. For aeronautical station transmitters with transmitter power up to and including 50 watts the attenuation must be at least $43 + 10 \log_{10} P_X$ dB and with transmitter power more than 50 watts the attenuation must be at least 60 dB.

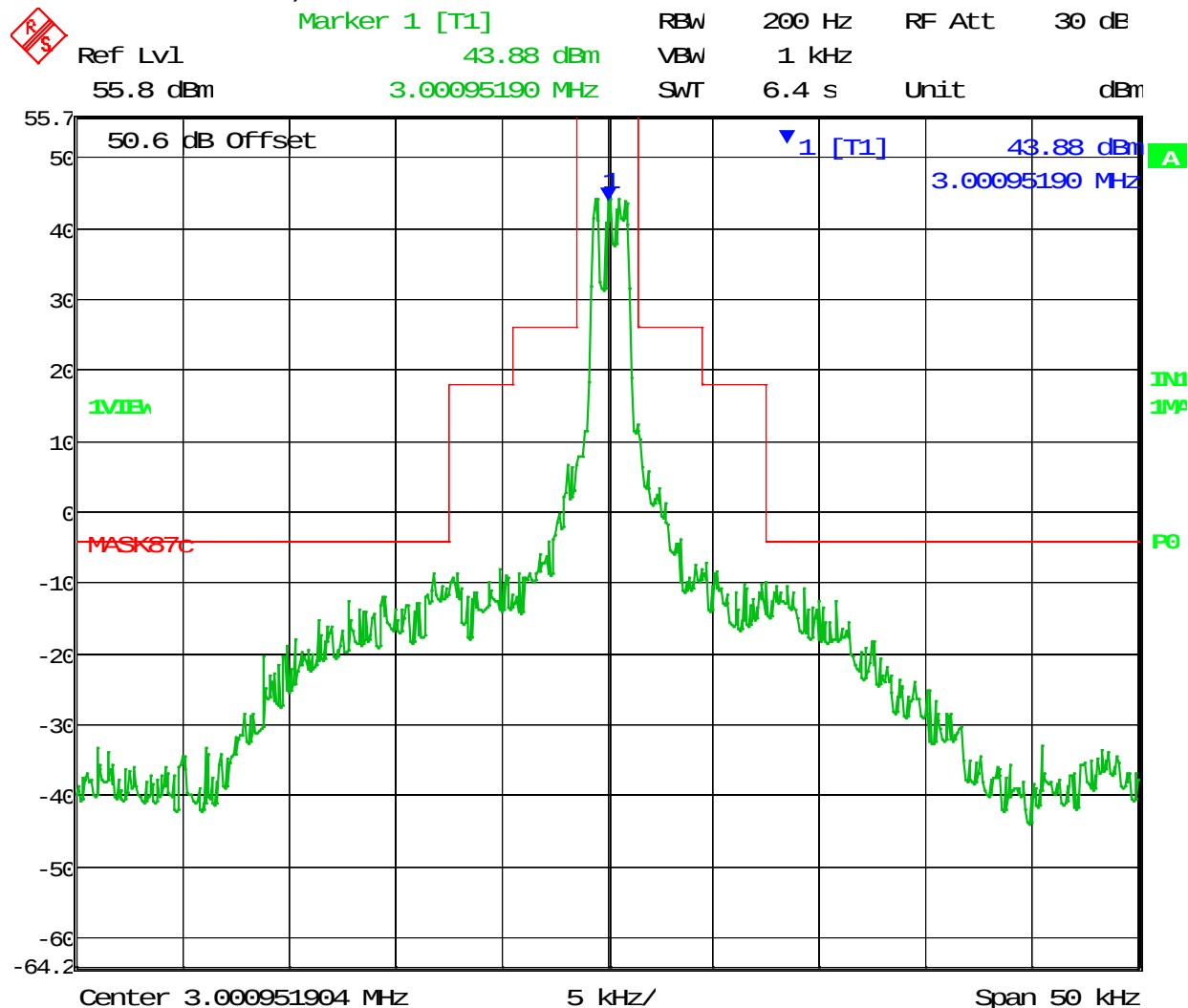
Method of Measurement: as referenced above

Test Setup Diagram:



OCCUPIED BANDWIDTH

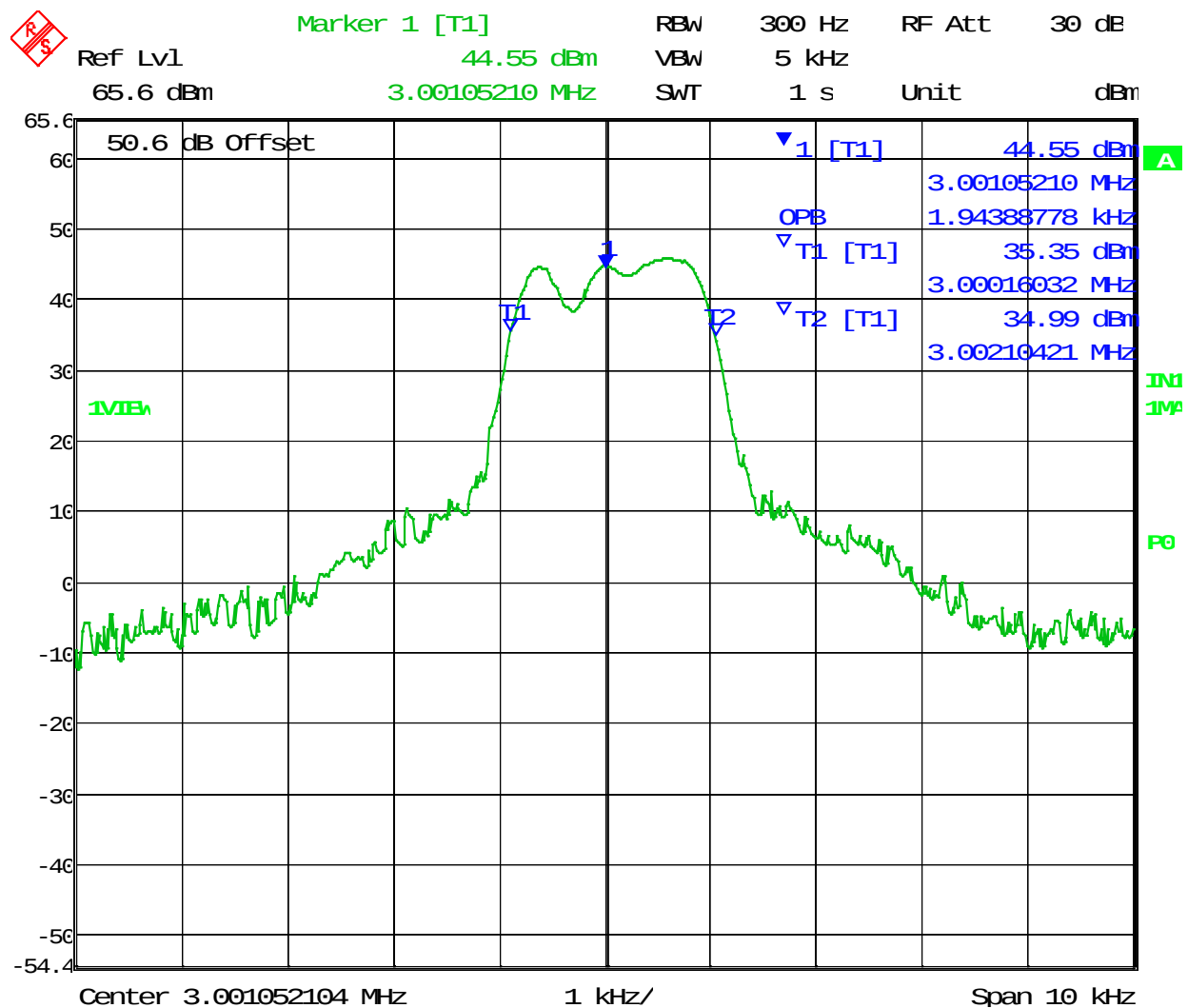
Test Data: 3 MHz, 2K80J3E/H3E



Date: 18.DEC.2017 13:45:22

OCCUPIED BANDWIDTH

Test Data: 3MHz 2K80J3E/H3E 99 % OBW Plot

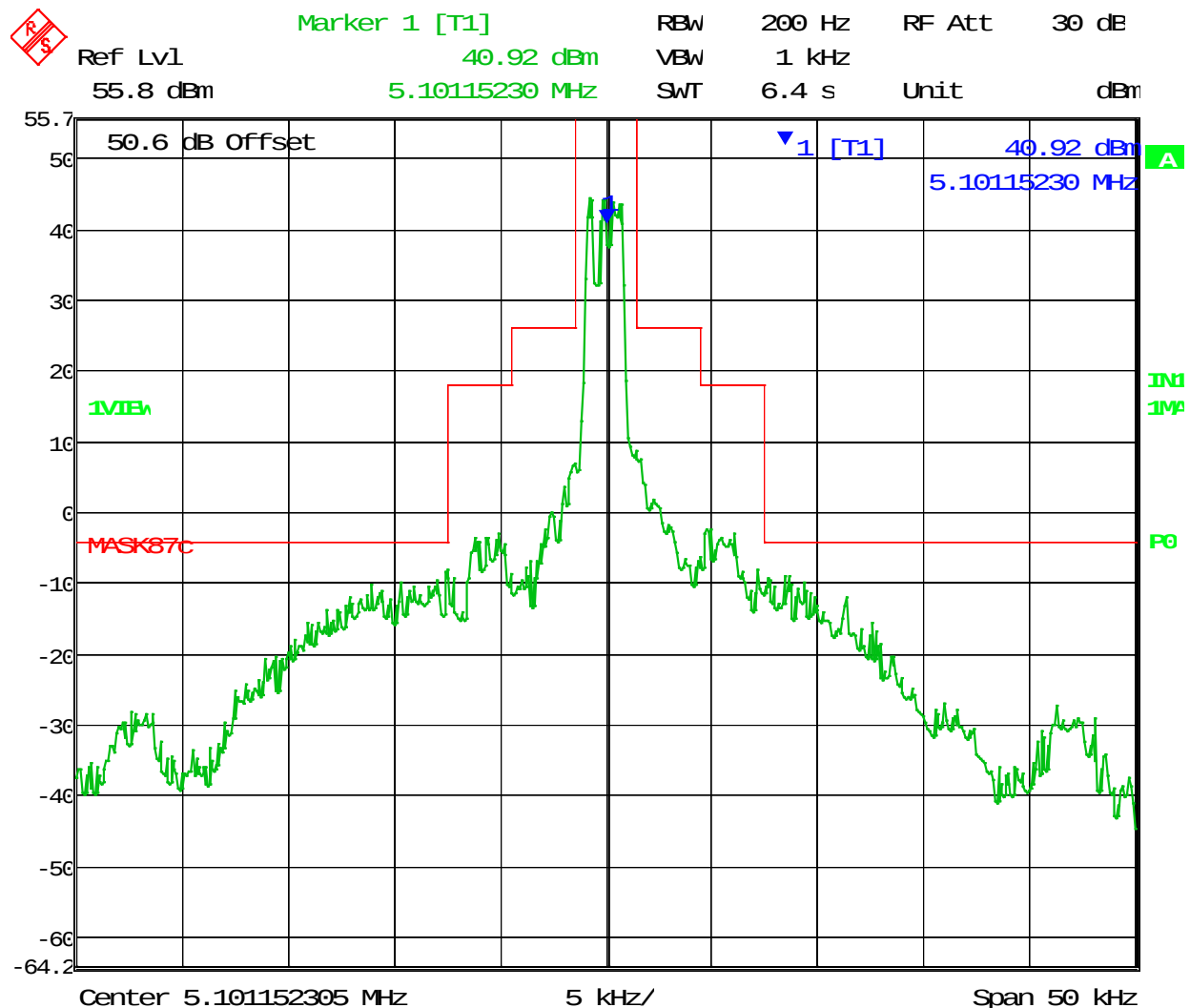


Date: 18.DEC.2017 14:56:27

99 % OBW of 3MHz 2K80J3E/H3E Signal: 1.94 kHz

OCCUPIED BANDWIDTH

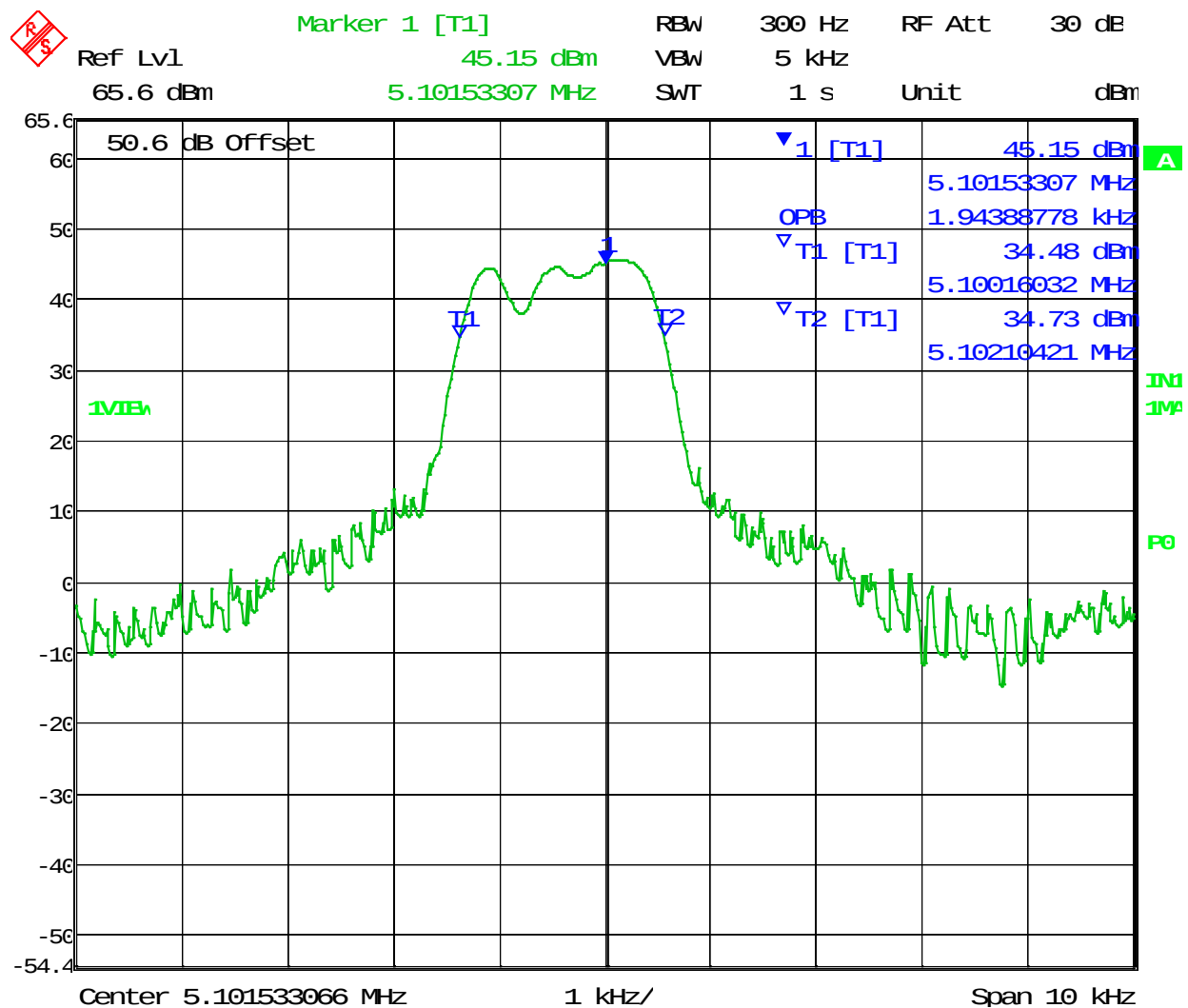
Test Data: 5.1 MHz, 2K80J3E/H3E



Date: 18.DEC.2017 13:47:10

OCCUPIED BANDWIDTH

Test Data: 5.1 MHz 2K80J3E/H3E 99 % OBW Plot

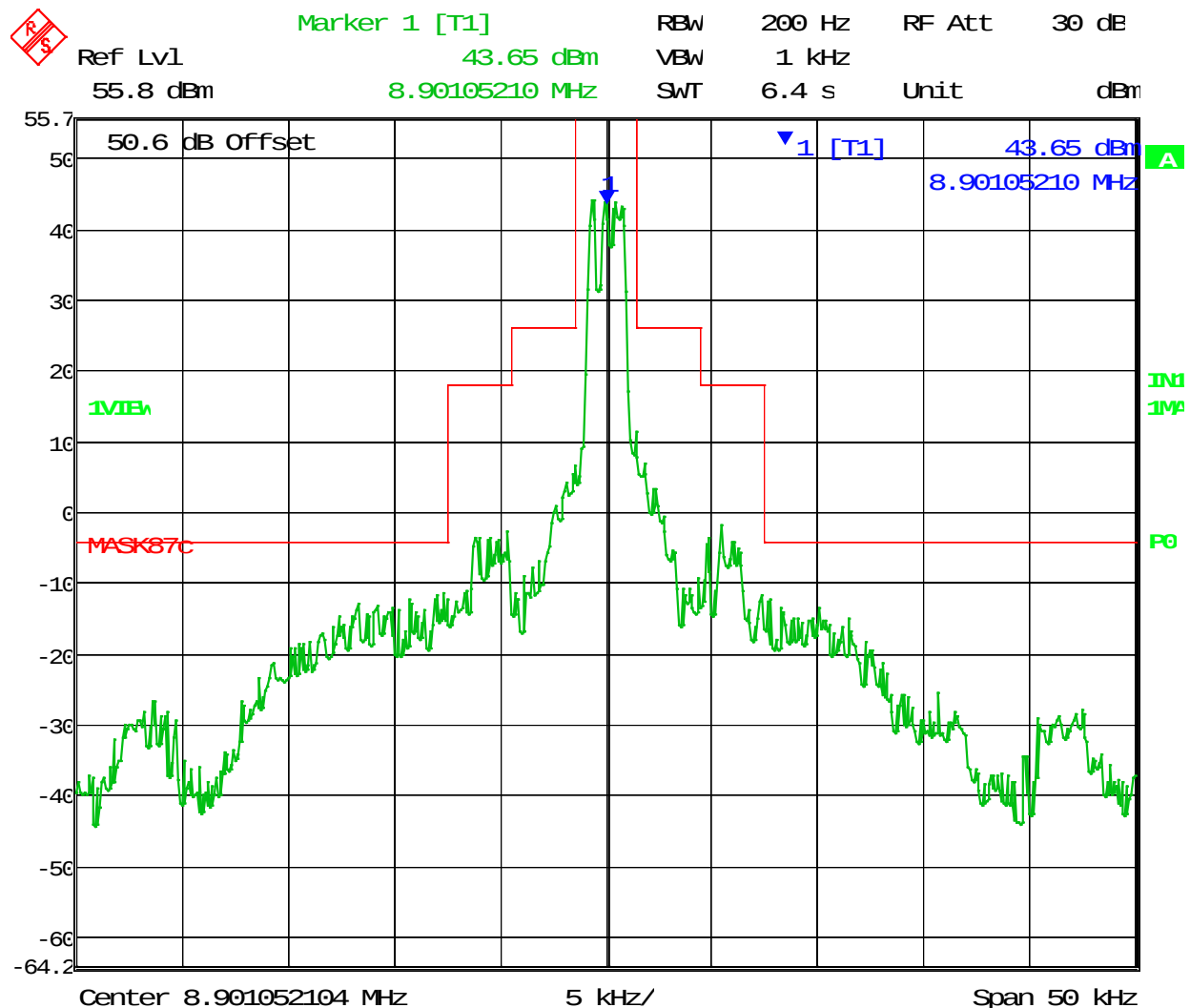


Date: 18.DEC.2017 15:00:26

99 % OBW of 5.1 MHz 2K80J3E/H3E Signal: 1.94 kHz

OCCUPIED BANDWIDTH

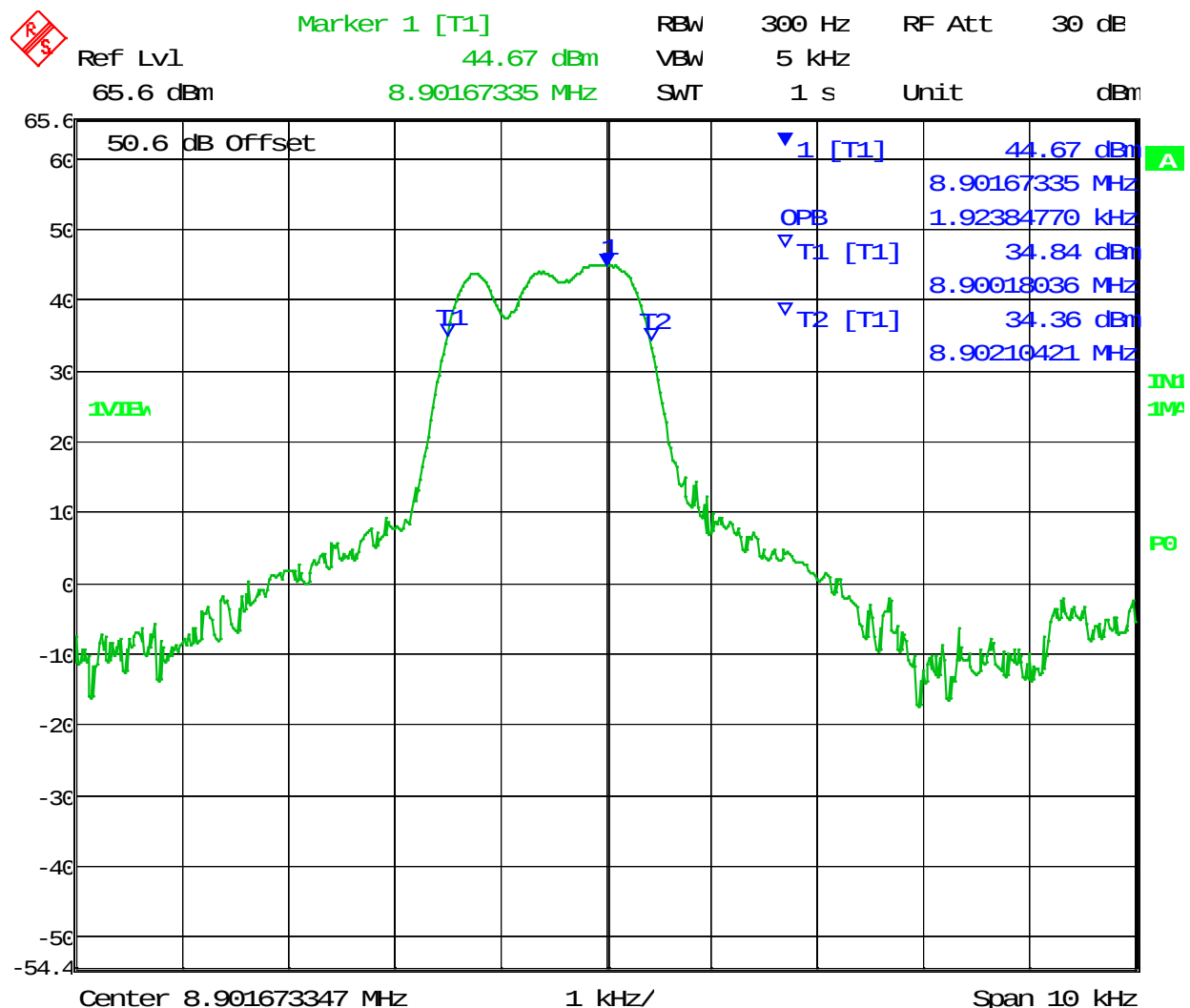
Test Data: 8.9 MHz, 2K80J3E/H3E



Date: 18.DEC.2017 13:48:02

OCCUPIED BANDWIDTH

Test Data: 8.9 MHz 2K80J3E/H3E 99 % OBW Plot

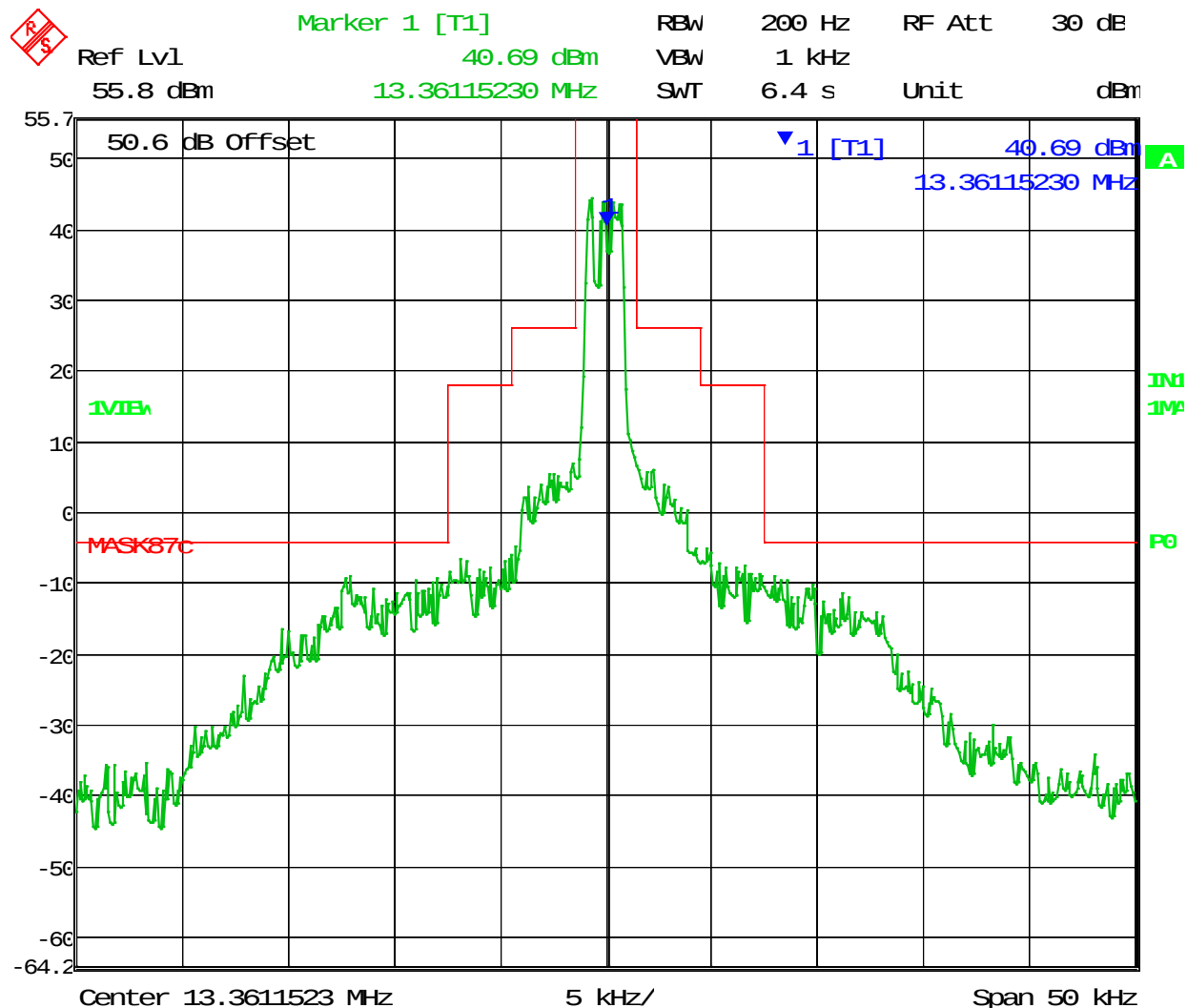


Date: 18.DEC.2017 15:01:26

99 % OBW of 8.9 MHz 2K80J3E/H3E Signal: 1.92 kHz

OCCUPIED BANDWIDTH

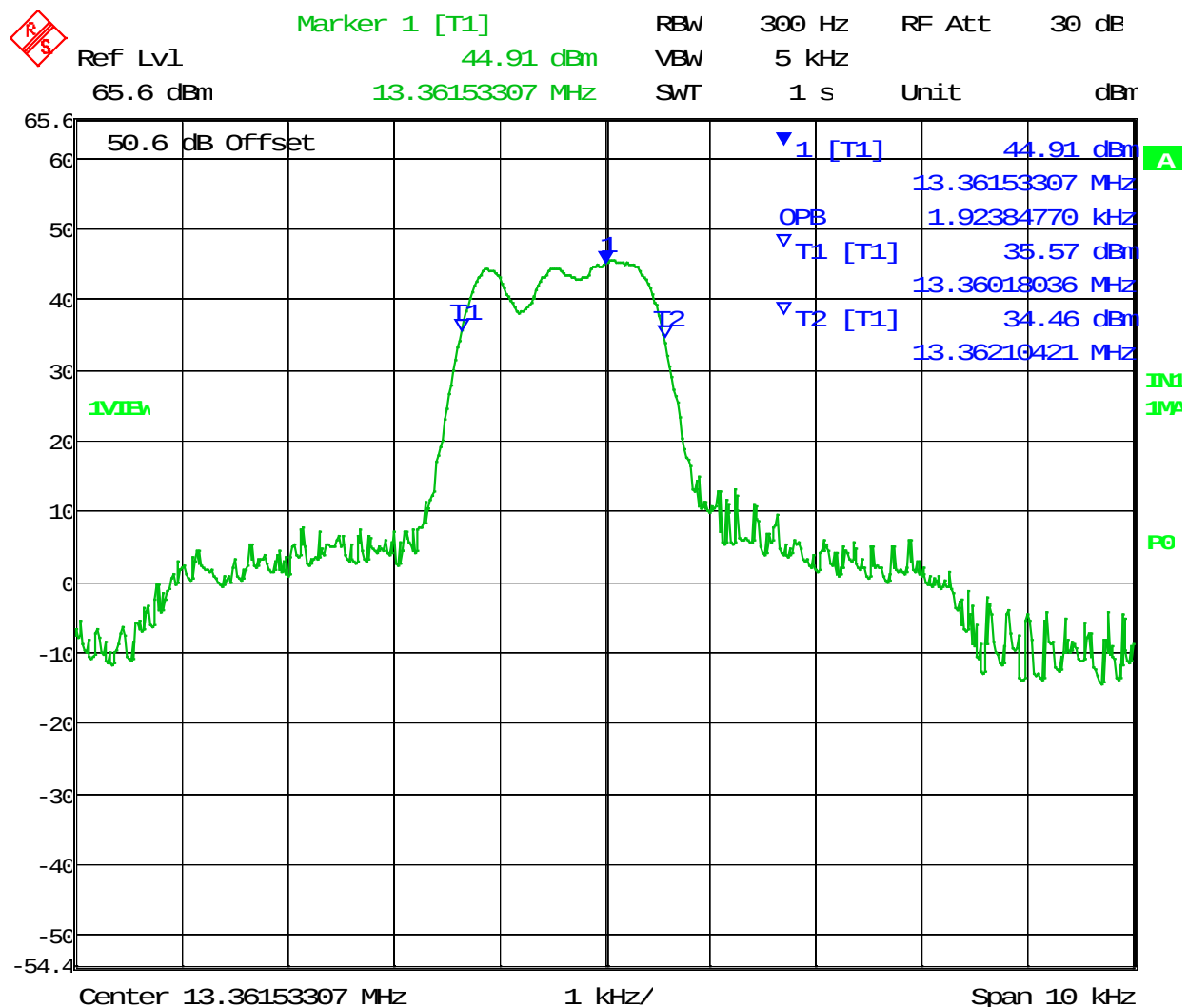
Test Data: 13.36 MHz, 2K80J3E/H3E



Date: 18.DEC.2017 13:49:07

OCCUPIED BANDWIDTH

Test Data: 13.36 MHz 2K80J3E/H3E 99 % OBW Plot



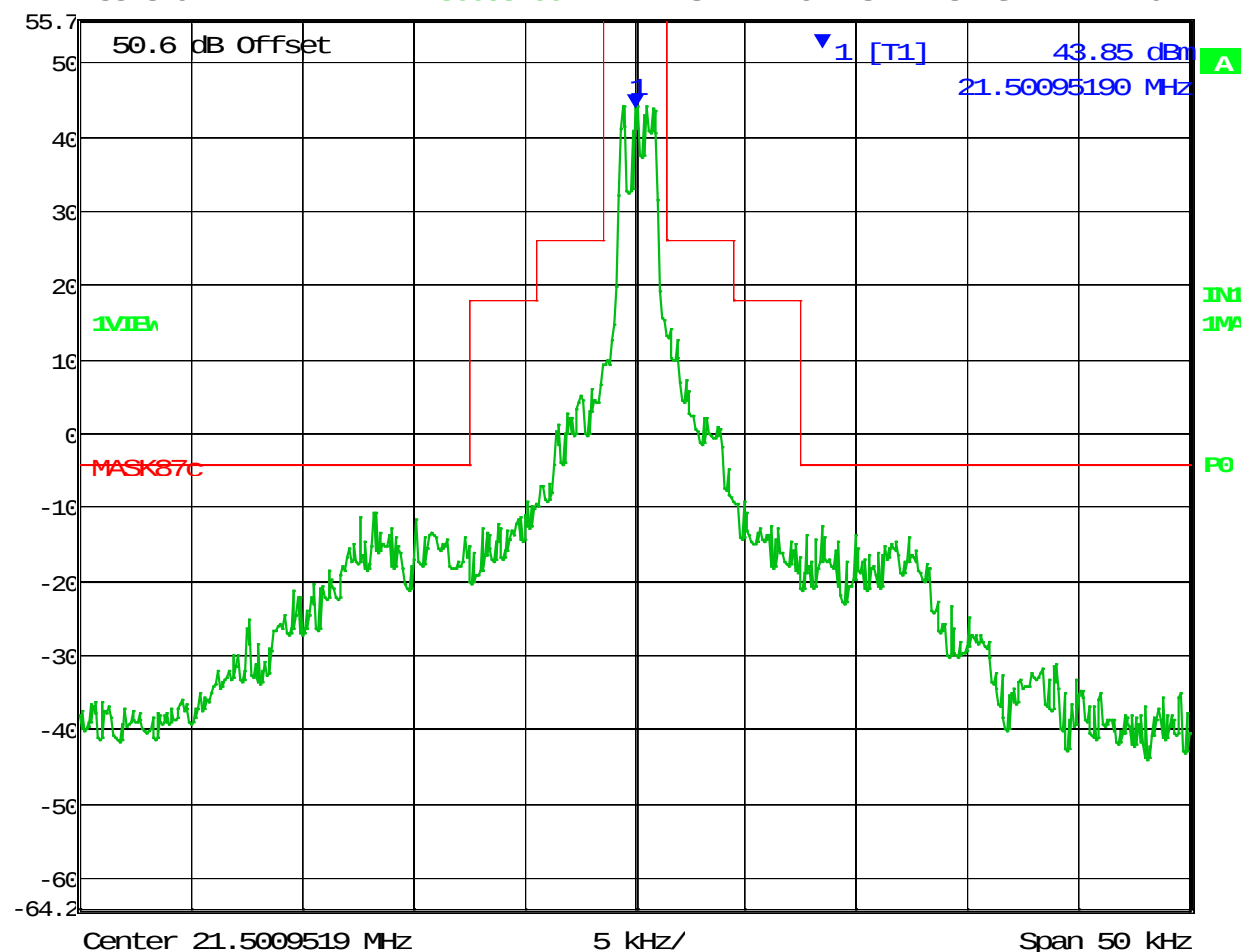
Date: 18.DEC.2017 15:04:09

99 % OBW of .13.36 MHz 2K80J3E/H3E Signal: 1.92 kHz

OCCUPIED BANDWIDTH

Test Data: 21.5 MHz, 2K80J3E/H3E

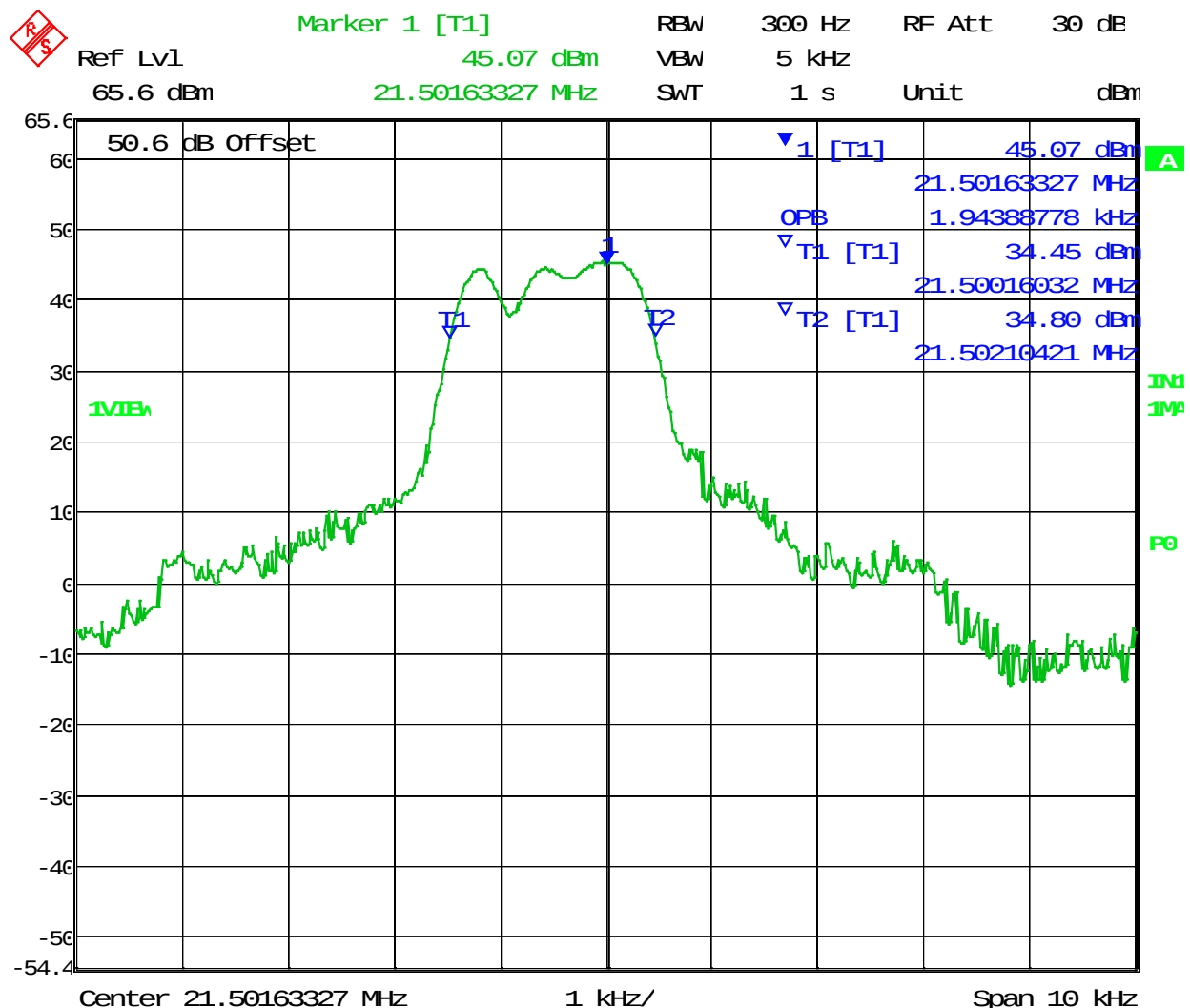

 Ref Lvl 55.8 dBm
 Marker 1 [T1] 43.85 dBm
 21.50095190 MHz
 RBW 200 Hz
 VBW 1 kHz
 SWT 6.4 s
 RF Att 30 dB
 Unit dBm



Date: 18.DEC.2017 13:50:06

OCCUPIED BANDWIDTH

Test Data: 21.5 MHz 2K80J3E/H3E 99 % OBW Plot

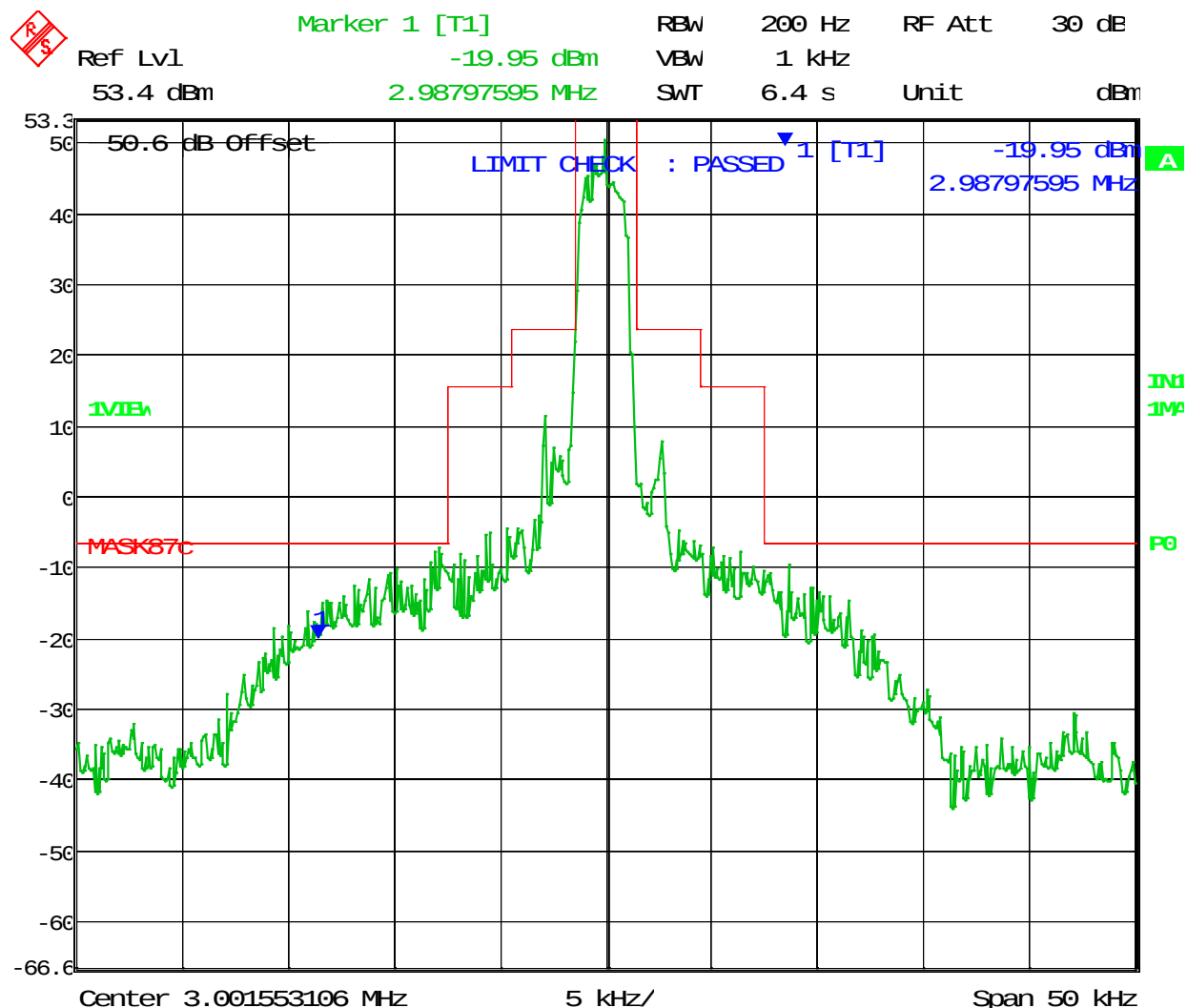


Date: 18.DEC.2017 15:05:03

99 % OBW of 21.5 MHz 2K80J3E/H3E Signal: 1.94 kHz

OCCUPIED BANDWIDTH

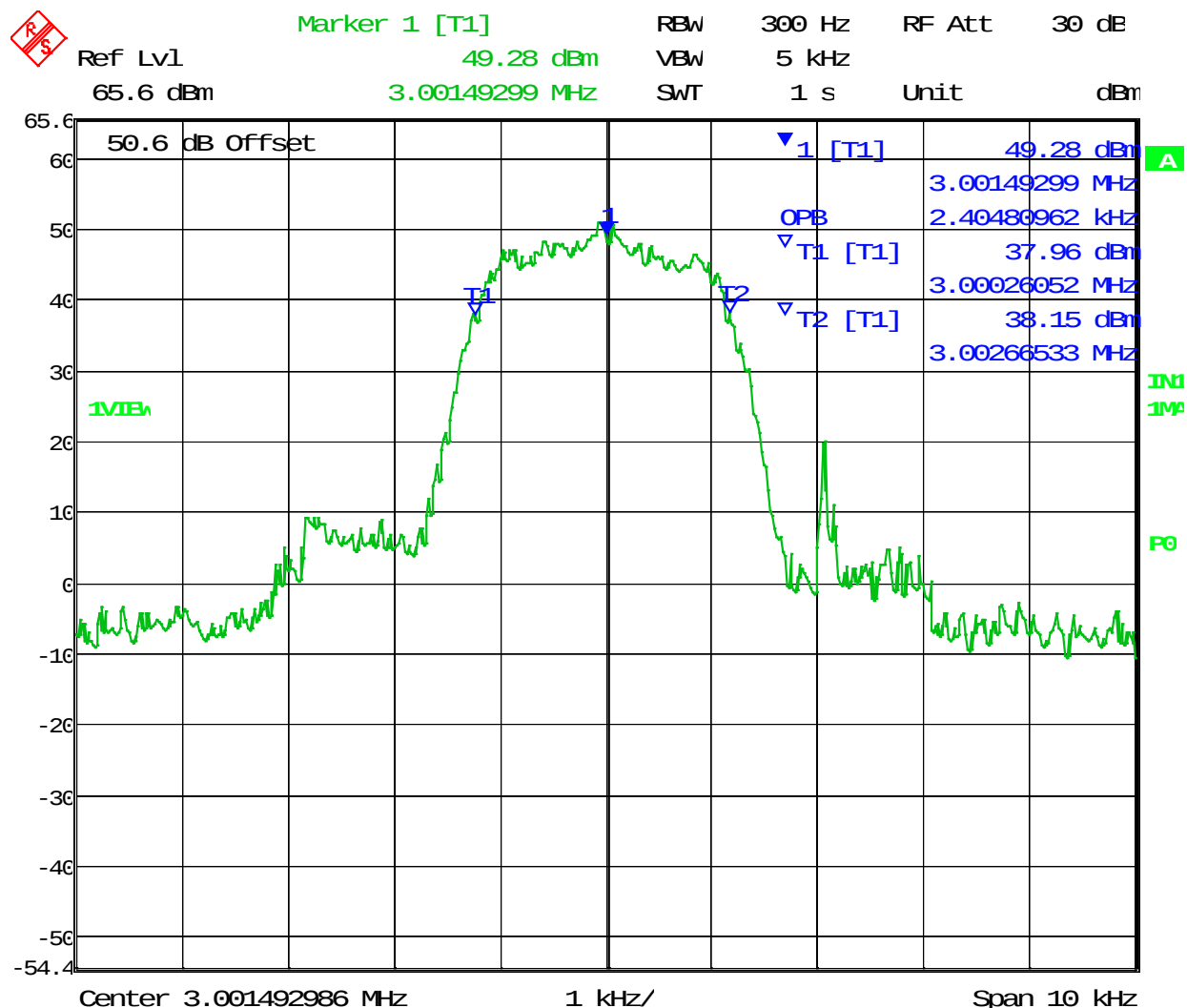
Test Data: 3MHz 2K80J2D



Date: 18.DEC.2017 14:05:47

OCCUPIED BANDWIDTH

Test Data: 3 MHz 2K80J2D 99 % OBW Plot

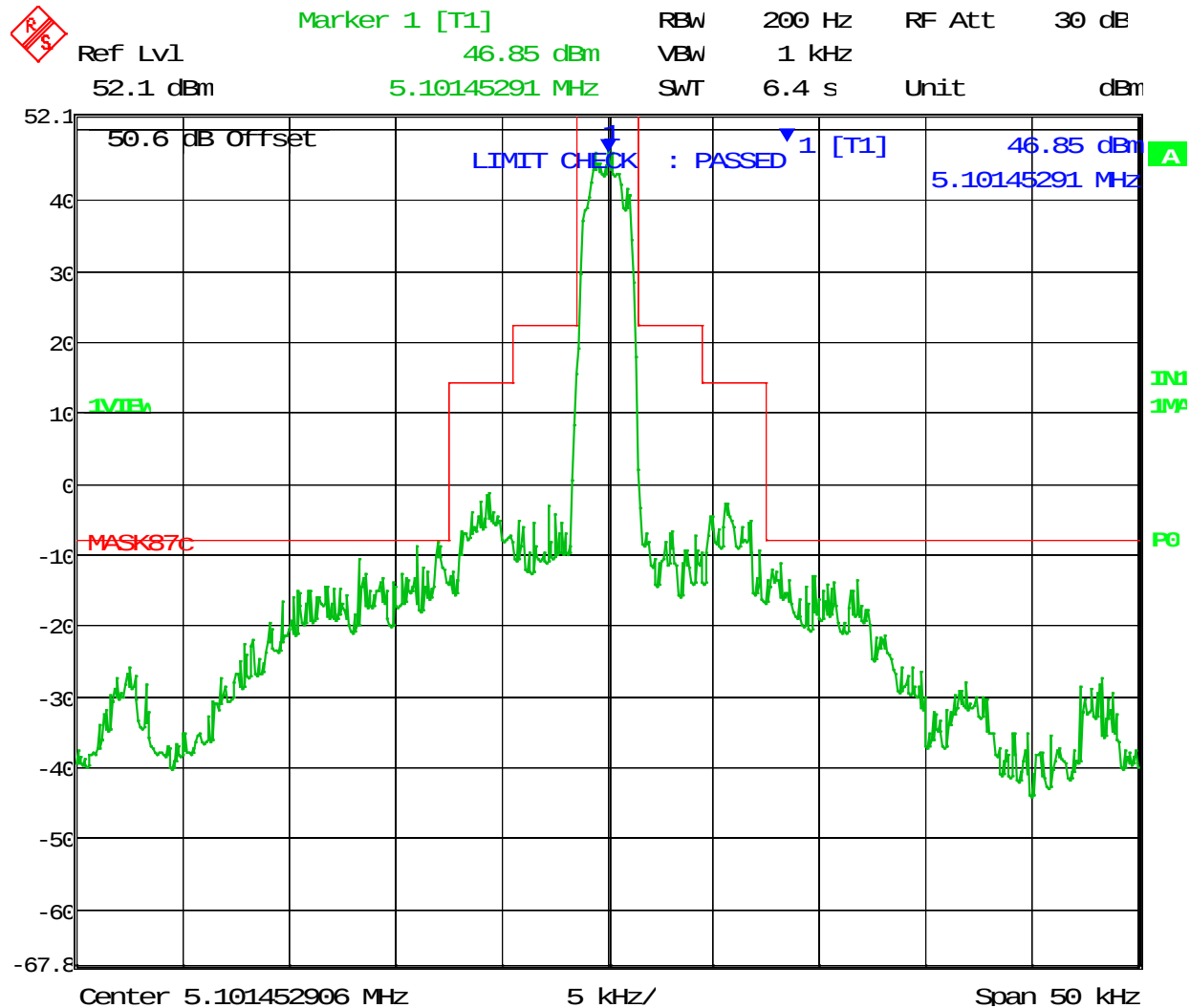


Date: 18.DEC.2017 14:57:41

99 % OBW of 3 MHz 2K80J2D Signal: 2.41 kHz

OCCUPIED BANDWIDTH

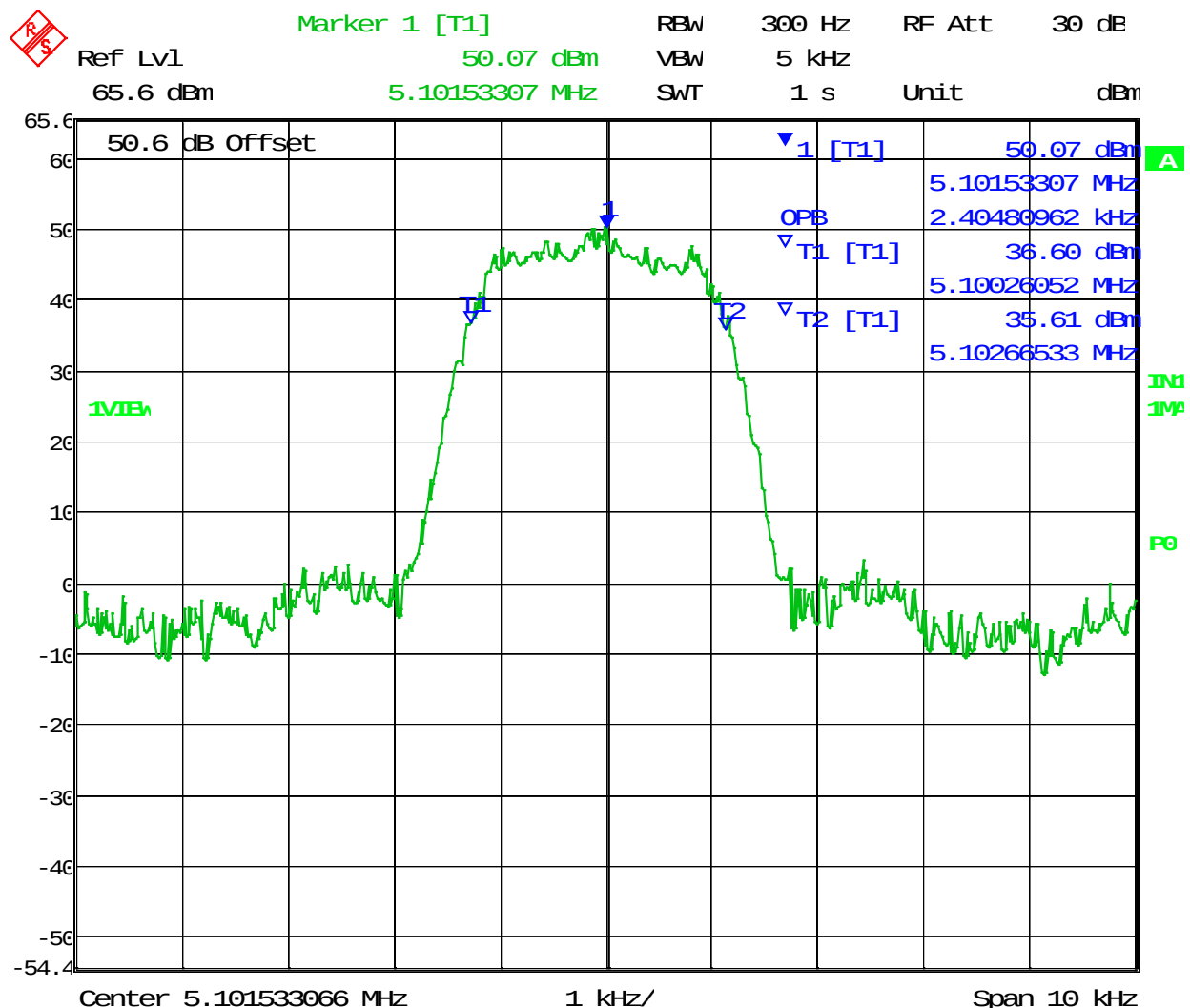
Test Data: 5.1 MHz 2K80J2D



Date: 18.DEC.2017 14:02:45

OCCUPIED BANDWIDTH

Test Data: 5.1 MHz 2K80J2D 99 % OBW Plot

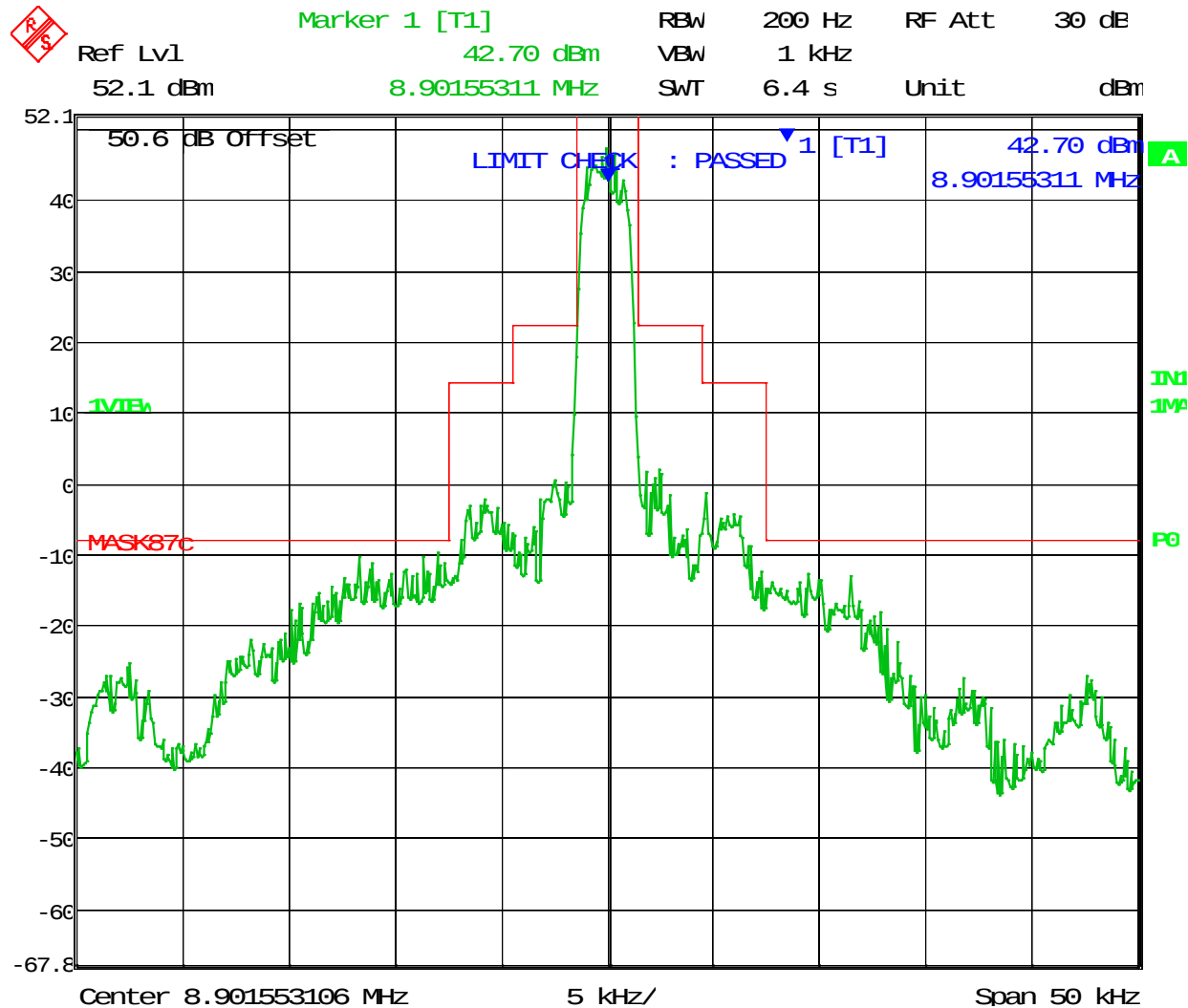


Date: 18.DEC.2017 14:59:51

99 % OBW of 3 MHz 2K80J2D Signal: 2.41 kHz

OCCUPIED BANDWIDTH

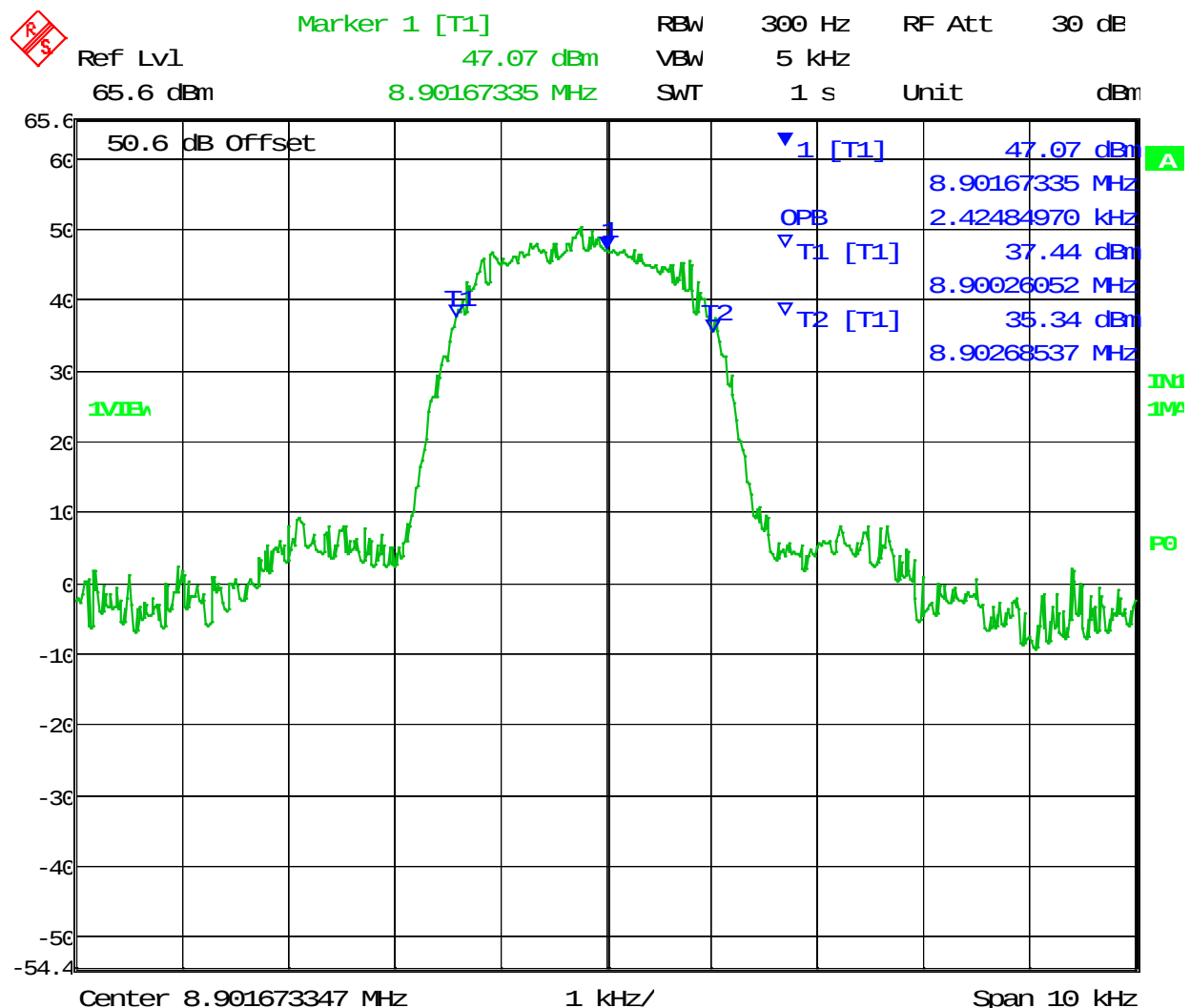
Test Data: 8.9 MHz 2K80J2D



Date: 18.DEC.2017 14:00:52

OCCUPIED BANDWIDTH

Test Data: 8.9 MHz 2K80J2D 99 % OBW Plot

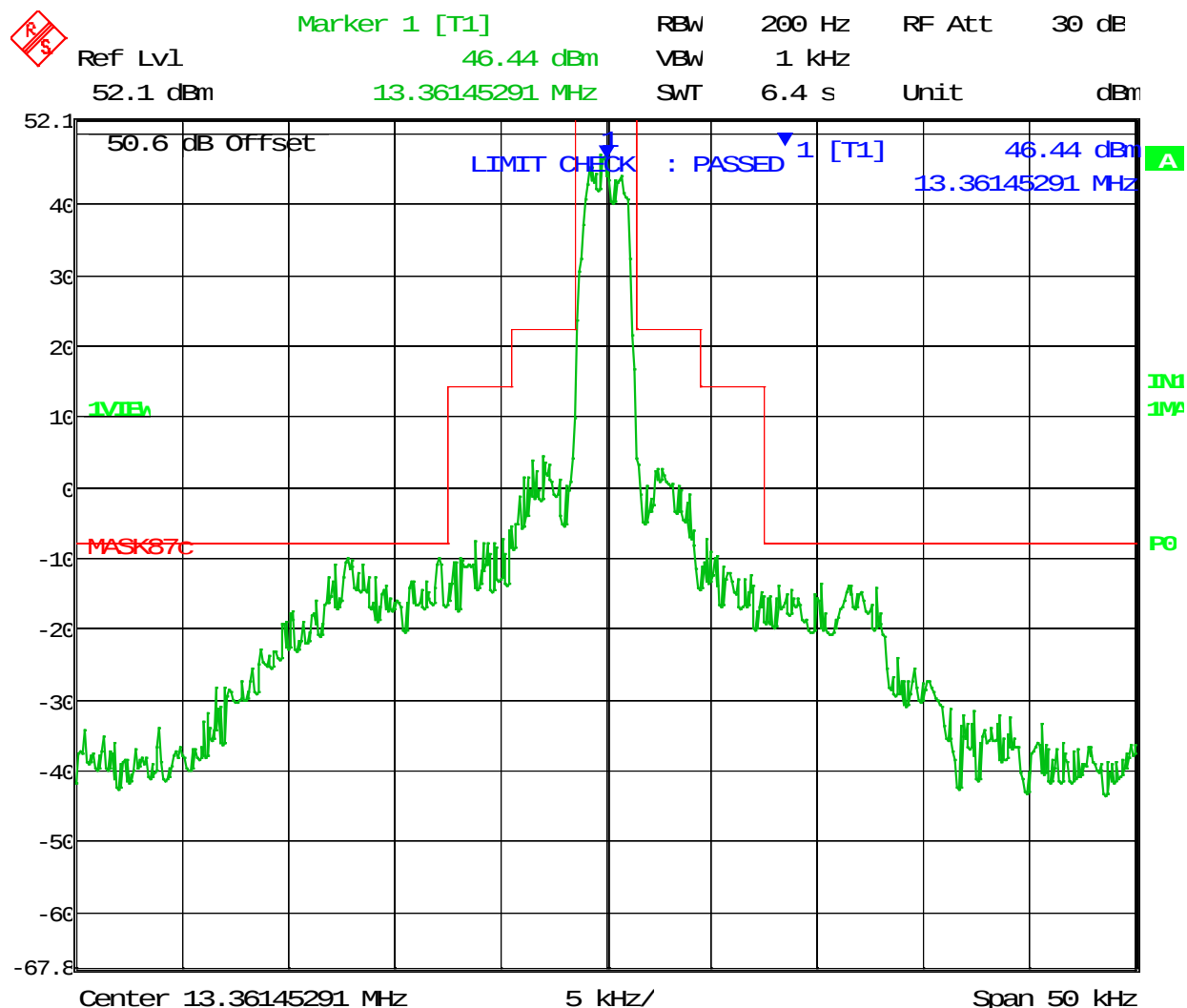


Date: 18.DEC.2017 15:02:28

99 % OBW of 3 MHz 2K80J2D Signal: 2.43 kHz

OCCUPIED BANDWIDTH

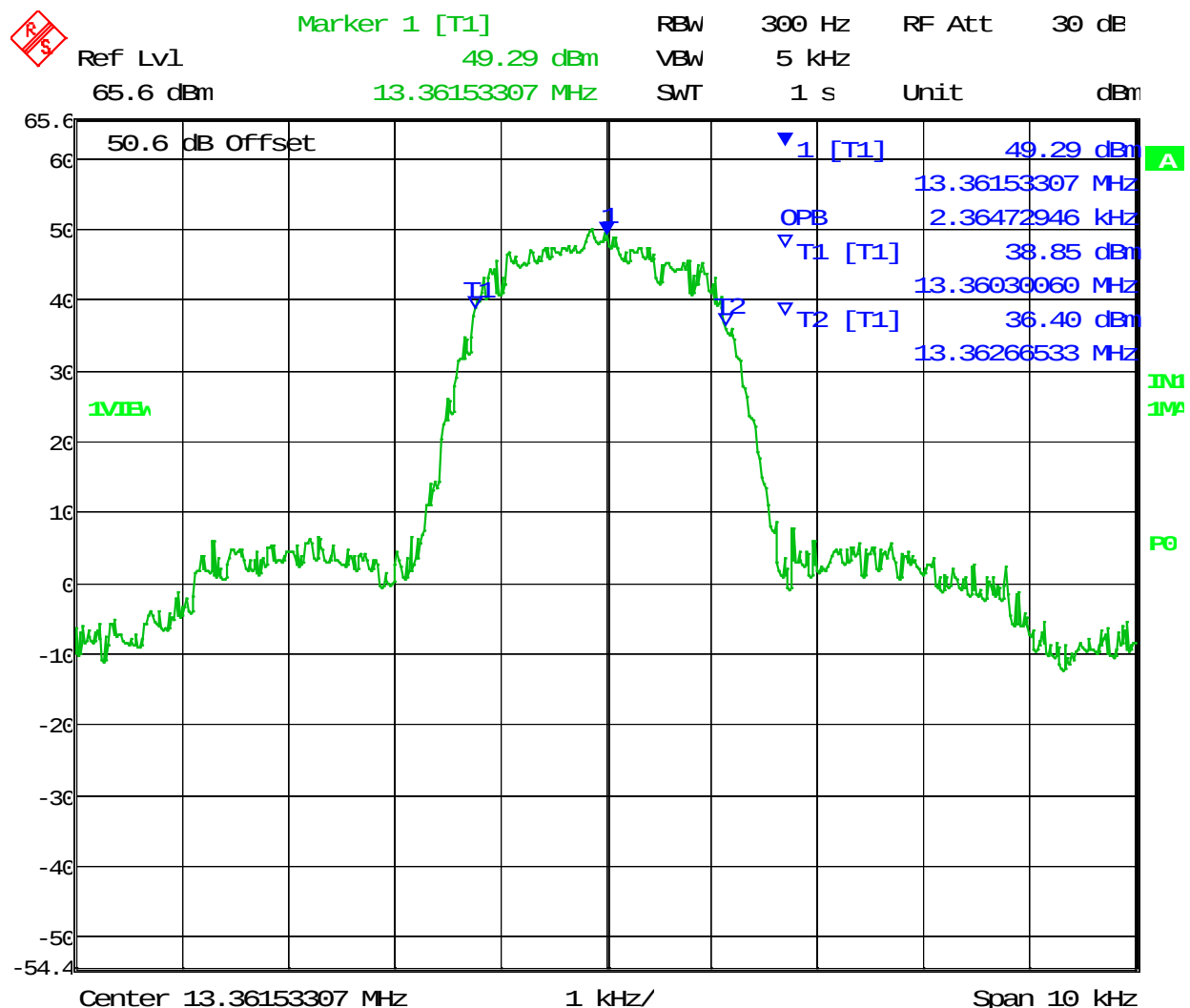
Test Data: 13.36 MHz 2K80J2D



Date: 18.DEC.2017 13:59:13

OCCUPIED BANDWIDTH

Test Data: 13.36 MHz 2K80J2D 99 % OBW Plot

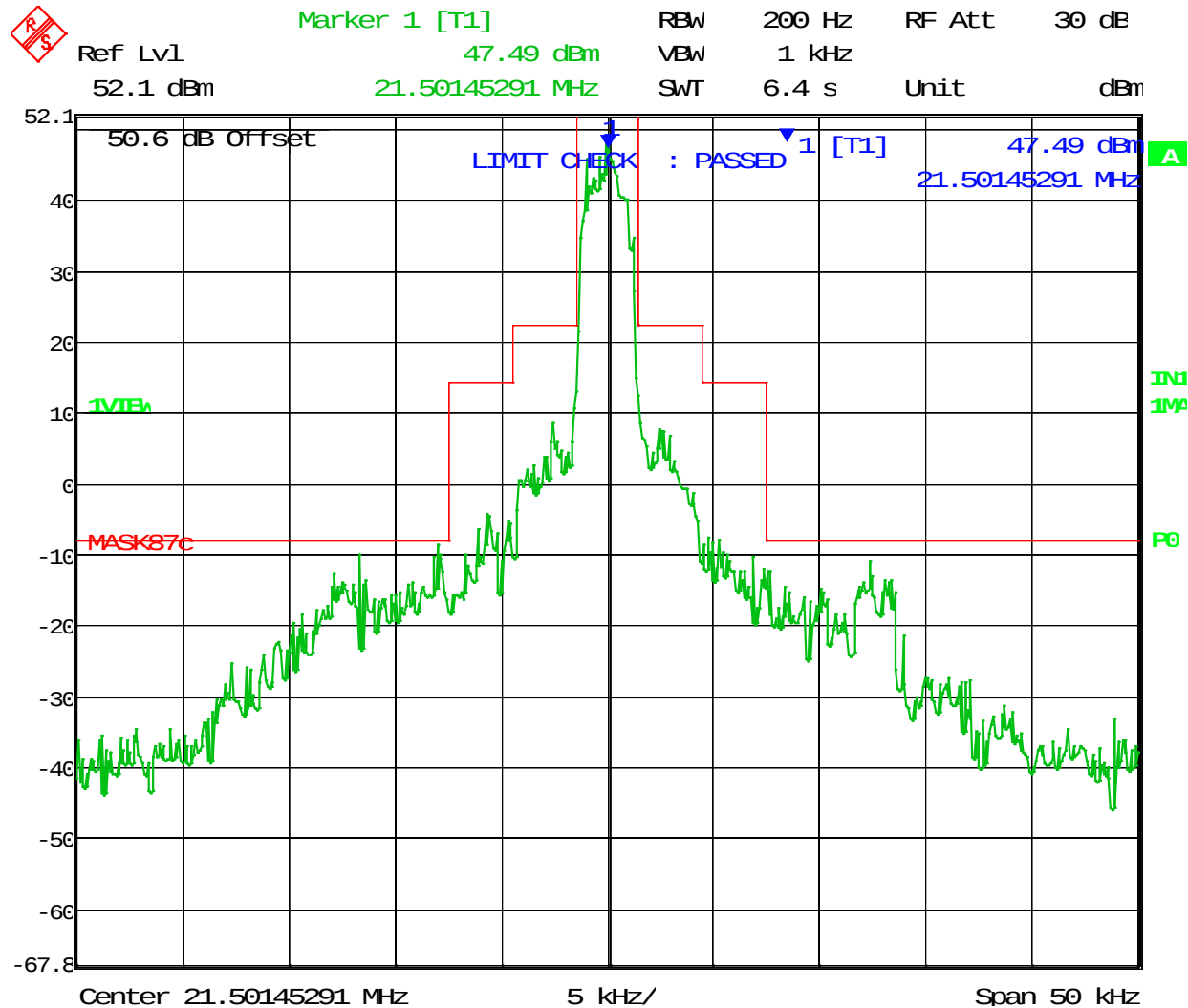


Date: 18.DEC.2017 15:03:18

99 % OBW of 13.36 MHz 2K80J2D Signal: 2.37 kHz

OCCUPIED BANDWIDTH

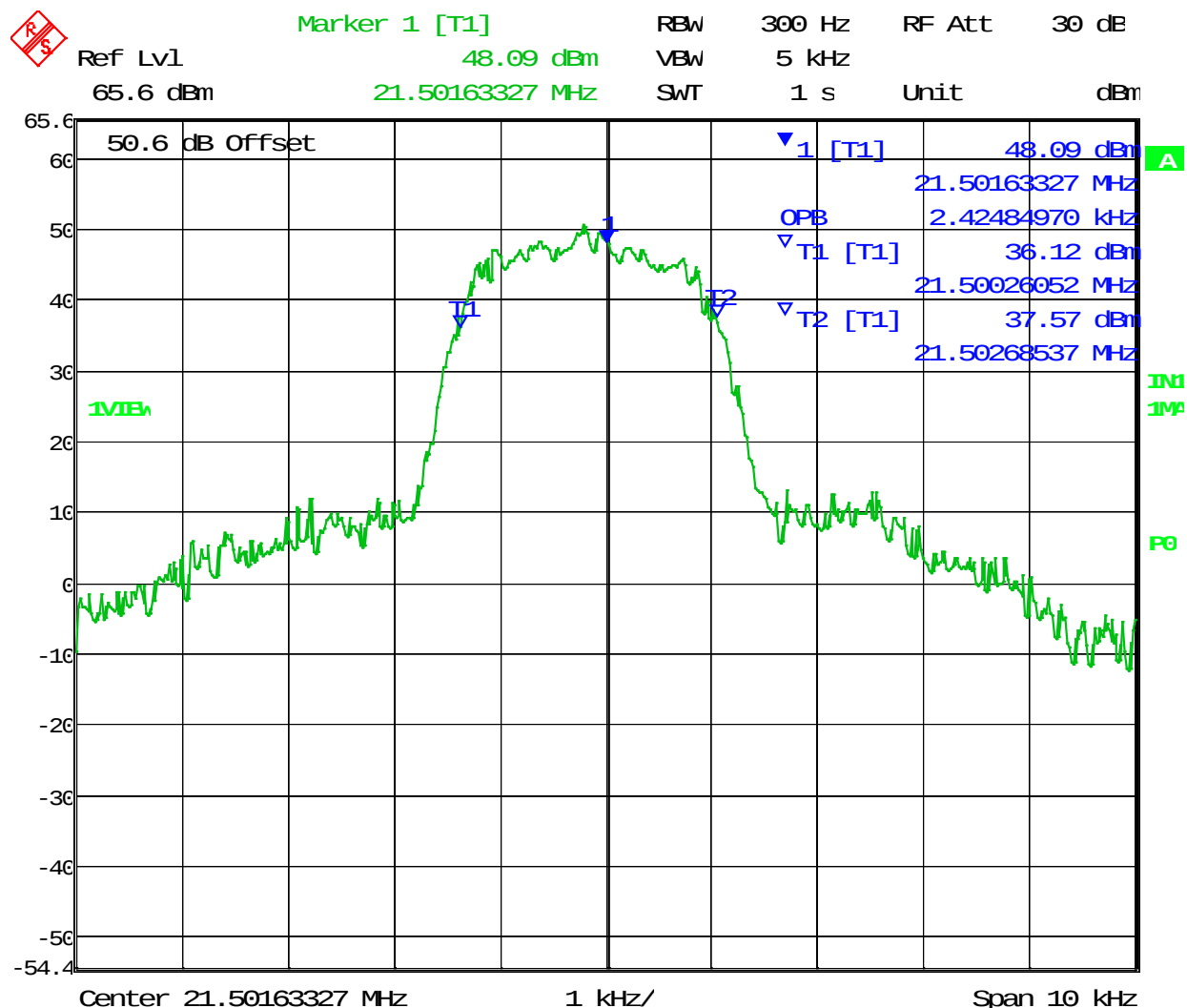
Test Data: 21.5MHz 2K80J2D



Date: 18.DEC.2017 13:57:31

OCCUPIED BANDWIDTH

Test Data: 21.5 MHz 2K80J2D 99 % OBW Plot



Date: 18.DEC.2017 15:05:51

99 % OBW of 21.5 MHz 2K80J2D Signal: 2.43 kHz

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Rule Part No.: Part 2.1051, 87.139

Requirements: see below

When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 60 dB.

Method of Measurement: The carrier was modulated 100% using a Test tone. The spectrum was scanned to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard TIA/EIA-603.

Test Data: Measurement Table 3 MHz, 2K80J3E/H3E

Power Output	dBm	Watts	Limit (dBm)
	55.57	360.58	12.57
Frequency		dBc	Margin
(fundamental)	3.000	0.00	0.00
	6.000	81.58	69.01
	9.000	102.68	90.11
*	12.000	118.48	105.91
	15.000	101.10	88.53
	18.000	109.10	96.53
	21.000	111.68	99.11
	24.000	118.48	105.91
*	27.000	118.48	105.91
	30.000	118.48	105.91
* Indicates Noise Floor			

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: Measurement Table 5.1 MHz, 2K80J3E / H3E

Power Output	dBm	Watts	Limit (dBm)
	55.57	360.58	12.57

Frequency	dBc	Margin
(fundamental) 5.100	0.00	0.00
10.200	83.58	71.01
15.300	104.68	92.11
* 20.400	120.48	107.91
25.500	103.10	90.53
30.600	111.10	98.53
35.700	113.68	101.11
40.800	120.48	107.91
* 45.900	120.48	107.91
51.000	120.48	107.91

* Indicates Noise Floor

Test Data: Measurement Table 8.9 MHz, 2K80J3E / H3E

Power Output	dBm	Watts	Limit (dBm)
	55.57	360.58	12.57

Frequency	dBc	Margin
(fundamental) 8.900	0.00	0.00
17.800	82.58	70.01
26.700	103.68	91.11
* 35.600	119.48	106.91
44.500	102.10	89.53
53.400	110.10	97.53
62.300	112.68	100.11
71.200	119.48	106.91
* 80.100	119.48	106.91
89.000	119.48	106.91

* Indicates Noise Floor

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: Measurement Table 13.36 MHz, 2K80J3E / H3E

Power Output	dBm	Watts	Limit (dBm)
	55.57	360.58	12.57

Frequency	dBc	Margin
(fundamental) 13.360	0.00	0.00
26.720	82.83	70.26
40.080	103.93	91.36
* 53.440	119.73	107.16
66.800	102.35	89.78
80.160	110.35	97.78
93.520	112.93	100.36
106.880	119.73	107.16
* 120.240	119.73	107.16
133.600	119.73	107.16
* Indicates Noise Floor		

Test Data: Measurement Table 21.5 MHz, 2K80J3E / H3E

Power Output	dBm	Watts	Limit (dBm)
	55.57	360.58	12.57

Frequency	dBc	Margin
(fundamental) 21.500	0.00	0.00
43.000	82.94	70.37
64.500	104.04	91.47
* 86.000	119.84	107.27
107.500	102.46	89.89
129.000	110.46	97.89
150.500	113.04	100.47
172.000	119.84	107.27
* 193.500	119.84	107.27
215.000	119.84	107.27
* Indicates Noise Floor		

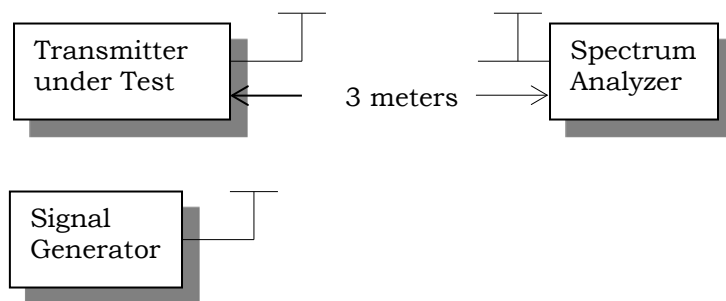
FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Parts. No.: Part 2.1053

Test Requirements: The FCC limits for radiated emissions are the same as previously stated for the conducted emissions.

Method of Measurements: The spectrum was scanned from 9 KHz to at least the tenth harmonic of the fundamental. This test was conducted per TIA/EIA STANDARD 603 using the substitution method.

Test Setup Diagram:



FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: Measurement Table 3 MHz, 2K80J3E / H3E

Power Output	dBm	Watts	Limit (dBm)
	55.35	342.77	12.35

Tuned Freq MHz	Emission Frequency MHz	Antenna Polarity	erp (dBm)	Margin
3	6	V	-86.26	141.61
3	9	V	-101.20	156.55
3	12	V	-96.91	152.26
3	15	V	-98.88	154.23
3	18	V	-87.48	142.83
3	21	V	-88.90	144.25
3	24	V	-90.57	145.92
3	27	V	-91.21	146.56
3	30	V	-76.18	131.53

FIELD STRENGTH OF SPURIOUS EMISSIONS

Test Data: Measurement Table 21.5 MHz, 2K80J3E / H3E

Power Output	dBm		Watts	Limit (dBm)
	54.89		308.32	11.89

Tuned Freq MHz	Emission Frequency MHz	Antenna Polarity	erp (dBm)	Margin
21.5	43	H	-81.5872	124.59
21.5	43	V	-80.0972	123.10
21.5	64.5	V	-69.1172	112.12
21.5	64.5	H	-68.0972	111.10
21.5	86	H	-78.6472	121.65
21.5	86	V	-80.8272	123.83
21.5	107.5	V	-81.2972	124.30
21.5	107.5	H	-87.4872	130.49
21.5	129	H	-83.2372	126.24
21.5	129	V	-87.9172	130.92
21.5	150.5	V	-86.4972	129.50
21.5	150.5	H	-85.4672	128.47
21.5	172	H	-81.3572	124.36
21.5	172	V	-80.5072	123.51
21.5	193.5	V	-79.4272	122.43
21.5	193.5	H	-76.4172	119.42
21.5	215	H	-83.2372	126.24
21.5	215	V	-80.0972	123.10

FREQUENCY STABILITY

Rule Parts. No.: Part 2.1055, Part 87.133

Requirements: Temperature range requirements: -30 to +50° C.
Voltage Variation $\pm 15\%$. Must maintain ± 50 Hz.

Method of Measurements: TIA/EIA Specification 603

Test Data: **Frequency Stability Measurement Table**

Temperature	Frequency (MHz)	Deviation (Hz)
25°C (reference)	10.0000070	
-30°C	9.9999972	9.8
-20°C	9.9999972	9.8
-10°C	9.9999972	9.8
0°C	9.9999972	9.8
10°C	9.9999971	9.9
20°C	9.9999971	9.9
30°C	9.9999971	9.9
40°C	9.9999971	9.9
50°C	9.9999970	10.0
Supply Voltage (VAC)	Frequency (MHz)	Deviation (Hz)
-15%	9.9999970	10.0
15%	9.9999970	10.0

EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
DC Power Supply	HP	6286A	1744A03842	N/A	N/A
Antenna: Biconical 1096	Eaton	94455-1	1096	08/01/17	08/01/19
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	07/26/17	07/26/19
Antenna: Log-Periodic 1243	Eaton	96005	1243	02/09/16	02/09/18
Temperature Chamber LARGE	Tenney Engineering	TTRC	11717-7	09/01/16	09/01/18
Frequency Counter Small Chamber	HP	5385A	3242A07460	08/22/17	08/22/19
Coaxial Cable - Chamber 3 cable set (backup)	Micro-Coax	Chamber 3 cable set (backup)	KMKM-0244-02 ; KMKM-0670-01; KFKF-0197-00	N/A	N/A
CHAMBER	Panashield	3M	N/A	04/25/16	01/31/18
Sweep/Signal Generator	Anritsu	68369B	985112	11/08/17	11/08/19
EMI Test Receiver R & S ESIB 40 Screen Room	Rohde & Schwarz	ESIB 40	100274	08/16/16	08/16/18
Software: Field Strength Program	Timco	N/A	Version 4.10.7.0	N/A	N/A
Antenna: Active Loop	ETS-Lindgren	6502	00062529		
Type K J Thermometer	Martel	303	080504494	11/06/17	11/06/19
Modulation Analyzer	HP	8901A	3050A05856	04/13/17	04/13/19
EMI Test Receiver R & S ESU 40 Chamber	Rohde & Schwarz	ESU 40	100320	04/01/16	04/01/18
Attenuator N 30dB 500W DC-2.5G	Bird	8325	1761	11/19/17	11/19/19
Tunable Notch Filter 15-30 MHz	Eagle	TNF-200	15-30 MHz (#17)	11/19/17	11/19/19
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	N/A	N/A

*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

STATE OF THE MEASUREMENT UC

The data and results referenced in this document are true and accurate. The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16–4 or ENTR 100-028 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: “Uncertainty in EMC Measurements” and is documented in the Timco Engineering, Inc. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device. Hereafter the best measurement capability for Timco Engineering, Inc. is reported:

Test Items	Measurement Uncertainty	Notes
RF Frequency Accuracy	± 49.5 Hz	(1)
RF Conducted Power	± 0.93 dB	(1)
Conducted spurious emission of transmitter valid up to 40GHz	± 1.86 dB	
Occupied Bandwidth	± 2.65 %	
Audio Frequency Response	± 1.86 dB	
Modulation limiting	± 1.88 %	
Radiated RF Power	± 1.4 dB	
Maximum frequency deviation: Within 300 Hz and 6kHz of audio freq. Within 6kHz and 25kHz of audio Freq.	± 1.88 % ± 2.04 %	
Rad Emissions Sub Meth up to 26.5GHz	± 2.14 dB	
Adjacent channel power	± 1.47 dB	(1)
Transient Frequency Response	± 1.88 %	
Temperature	± 1.0 °C	(1)
Humidity	± 5.0 %	

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=1.96$.

END OF REPORT